Trapping and Coded Wire Tagging of Wild Juvenile Chinook Salmon in the South Thompson/Shuswap River System, 1976, 1979 and 1980

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by

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TABLE OF CONTENTS

	Page
List of Figures	iv
List of Tables	v
List of Appendices	vi
ABSTRACT	viii
INTRODUCTION	1
DESCRIPTION OF STUDY AREA	1
SALMONID RESOURCE	1
METHODS	2
Fry Capture	2
1976	2
1979-80	6
Incline Plane Trap	6
Beach Seining	8
Fry Rearing	8
Fry Tagging	9
Tag Recapture	10
Biological Sampling	10
Physical Sampling	11
RESULTS	11
Fry Capture	11
Fry Rearing	13
Fry Tagging	13
Tag Recapture	18
Biological Sampling	18
Physical Sampling	24
DISCUSSION	24
Migration Timing	24
Natural and Pen Reared Fry Size	29
Fry Mortality	30
SUMMARY	31
ACKNOWLEDGEMENTS	32
References	32
APPENDICES	34

LIST OF FIGURES

FIGURE		Page
1.	Shuswap system, B.C.	3
2.	Location of seining and tagging sites, Shuswap System, 1976	5
3.	Location of road access, trapping, seining, rearing and tagging sites, lower Shuswap River, 1979, 1980	7
4.	Positioning of 4x4 and 2x3 incline plane traps across the lower Shuswap River off Cooke Creek, April, 1979	6
5.	Floating raceway used for rearing in 1979	9
6.	Floating tagging platform in Little Shuswap Lake, 1976	10
7.	Daily chinook fry catches per trap, lower Shuswap River, April-May, 1979	15
8.	Daily chinook fry catches per trap, lower Shuswap River, April-May, 1980	17
9.	Mean length and weight of naturally rearing and pen rearing chinook juveniles, lower Shuswap River, 1979, 1980	23
10.	Water level in Little Shuswap Lake, May-August, 1972-1976	25
11.	Surface water temperatures at trapping and seining sites, and water levels, lower Shuswap River, 1979, 1980	26
12.	Water temperatures at rearing pens, Mabel Lake, April-June, 1979, 1980	27

LIST OF TABLES

TABLE		Page
1.	Escapements of chinook, coho and sockeye to the middle and lower Shuswap rivers, and of chinook and coho to the South Thompson system, 1951-1980	4
2.	Estimated catch of chinook fry by beach seine in the Shuswap-South Thompson River system, June-August, 1976	12
3.	Estimated number of chinook fry caught in the lower Shuswap River, 1979, 1980	14
4.	Chinook pen rearing summary, pens 1 to 4 and raceway, Mabel Lake, 1979	16
5.	Chinook pen rearing summary, pens 1 to 4, Mabel Lake, 1980	16
6.	Chinook fry tagging summary, 1976, 1979, 1980	19
7.	Mean length of juvenile chinook from Shuswap Lake, Little Shuswap Lake and South Thompson River seining sites, June-August, 1976	20
8.	Mean length, weight and condition factor of naturally rearing and pen rearing chinook fry, lower Shuswap system, 1979	21
9.	Mean length, weight and condition factor of newly caught (naturally rearing) and pen rearing chinook fry, lower Shuswap system, 1980	22

LIST OF APPENDICES

Appendix		Page
1.	Mara Lake sampling, 1976	35
2.	Location of beach seining sites, lower Shuswap River, 1980	36
3.	Oregon Pellet feeding chart used in the Shuswap chinook rearing program, 1979, 1980	37
4a.	Estimated daily catch of juvenile chinook by beach seine, number of sets, and catch per unit effort, Little Shuswap Lake seining sites (S), 1976	38
4b.	Estimated daily catch of juvenile chinook by beach seine, number of sets, and catch per unit effort, Shuswap and Mara lake seining sites (S), 1976	39
4c.	Estimated daily catch of juvenile chinook by beach seine, number of sets, and catch per unit effort, South Thompson River seining site (S), 1976	40
5.	Number of chinook fry caught per trap, lower Shuswap River, 1979	41
6.	Number of chinook fry caught per trap, lower Shuswap River, 1980	43
7.	Chinook fry catches and water temperature data, lower Shuswap River, 1980	44
8a.	Daily beach seine catch of fish other than chinook juveniles, and number of sets per day, Little Shuswap Lake, 1976	45
8b.	Daily beach seine catch of fish other than chinook juveniles, and number of sets per day, Shuswap Lake, Mara Lake and South Thompson River, 1976	47
9.	Age, estimated catch and size of salmonid juveniles other than chinook fry, lower Shuswap River, 1979, 1980 (n gives sample size)	49
10.	Shuswap tagging results 1976	50
11.	Shuswap tagging results 1979	52
12.	Shuswap tagging results 1980	52
13.	Juvenile tag recovery data	53
14.	Mean nose-fork length and weight of rearing chinook fry in each enclosure, Mabel Lake, April to June, 1979	54
15.	Mean nose-fork length and condition factor of rearing chinook fry in each pen, Mabel Lake April to June, 1980	55

LIST OF APPENDICES CONT'D.

Appendix		Page
16a.	Surface water temperatures at Shuswap and Little Shuswap Lake seining sites, 1976	56
16b.	Water temperatures in Shuswap and Little Shuswap Lakes, August 2, 1976	57
16c.	Surface water temperatures at South Thompson River seining sites (S), 1976	58
17.	Surface water temperatures (C) at tagging sites, Shuswap - South Thompson River system, 1976	59
18.	Surface water temperatures (C) water levels and estimated velocities at trap entrances, lower Shuswap River, 1979	60
19.	Water temperatures (T) in rearing pens, Mabel Lake, April to June, 1979, 1980	61
20.	Water level (m) at Mabel Lake outlet, April to June, 1979 (from: Water Survey of Canada records; station did not operate in 1980)	62
21.	Surface water temperatures (C) water levels and estimated velocities at trap entrances, lower Shuswap River, 1980	63
22.	Water level and flow per pen, Mabel Lake, 1980	63

ABSTRACT

Fedorenko, A.Y., and B.C. Pearce. 1982. Trapping and Coded Wire Tagging of wild Juvenile Chinook Salmon in the South Thompson/Shuswap River System 1976, 1979, 1980. Can. MS. Rep. Fish. Aquat. Sci. 1677. 63 pp.

Juvenile chinook salmon (**Oncorhynchus tshawytscha**) were captured in the South Thompson River System for coded wire tagging during 1976, 1979 and 1980.

From June to August 1976, juvenile chinook were captured by beach seine from Shuswap and Little Shuswap lakes and the South Thompson River. An estimated 19,034 tagged chinook (corrected for mean tag rejection of 3.8% and mean mortality of 53.9%) were released with tag code 2-15-6. Size of tagged chinook ranged from 50-105 mm. Approximately 15,578 chinook died before and after tagging due largely to excessive handling of smolting fish and stress from high water temperatures. Water temperatures during 1976 seining and tagging ranged from 10-20°C.

During April and May 1979 and 1980, emergent chinook fry from the lower Shuswap River were captured by incline plane trap. Additional fish were captured in downstream rearing areas by beach seine. Captured fish were reared in net pens in Mabel Lake until they reached taggable size (mean 60 mm). After correction for tag rejection and mortality an estimated 141,502 and 57,842 tagged chinook were released in 1979 and 1980 respectively (codes 2-16-25 and 2-16-38 in 1979 and codes 2-16-1 and 2-17-55 in 1980). Mean tag rejection was 0.7% in 1979 and 2.5% in 1980. Total mortality during respective years was 2% and 6%. In both years fry reared in net pens increased in mean size from 38mm to 60mm and from 0.5g to 2.7g in 1979 and to 2.5g in 1980. Naturally rearing chinook had a mean size of 38mm to 39mm and 0.4g to 0.6g in 1979 (April to May); and 38mm to 57mm and 0.5g to 2.3g in 1980 (April to June). Water temperatures during fry capture and pen rearing did not exceed 16° in either year.

Key Words: Chinook salmon, Shuswap River, Coded wire tagging.

RESUME

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Le présent rapport porte sur la capture de saumons quinnats juvéniles dans le système de la rivière South Thompson, en 1976, 1979 et 1980, et de leur étiquetage à l'aide de fil métallique code.

De juin à août 1976, les juvéniles ont été capturés à l'aide d'une senne de rivage dans les lacs Shuswap et Little Shuswap et dans la rivière South Thompson. On a relâché 19,034 poissons étiquettés dont la longueur variait de 50 à 105 mm (code 2-15-6; 96.2% de rétention des étiquettés). Environ 15,578 autre saumoneaux sont morts avant et après l'étiquetage, surtout par suite d'une manipulation excessive et du stress causé par la température trop élevée de l'eau, qui variat de 10 à 20°C au cours des activités de pêche et d'étiquetage.

En avril et mai 1979 et 1980, des alevins ont été capturés dans la partie inférieure de la rivière Shuswap à l'aide de trappes à plan incliné. D'autres poissons ont été pris à la senne de rivage dans les frayères en aval. On les a élevés dans des parcs en filet dans le lac Mabel jusqu'à ce qu'ils atteignent une taille convenable pour l'étiquetage (60 mm en moyenne). En 1979 et 1980, 141,502 (codes 2-16-25 et 2-16-38; 99.3% de rétention des étiquettes) et 57,842 (codes 2-16-1 et 2-17-55; 97.4% de rétention des étiquettes) saumons quinnats ont été relâchés, respectivement. La mortalité totale pour chaque année s'élève à 2% et 6%. Au cours de ces deux années, la longueur moyenne des alevins élevés dans les parcs en filet est passée de 38 mm à 60 mm, le poids moyen, de 0,5 g à 2,7 g en 1979 et à 2,5 g en 1980. En 1979 (avril et mai), la longueur moyenne des saumons quinnats sauvages a varié de 38 mm à 39 mm et le poids moyen, de 0,4 g à 0,6 g; en 1980 (avril à juin), la longueur moyenne a été de 38 mm à 57 mm et le poids moyen, de 0,5 g à 2,3 g. La température de l'eau au cours de la capture des alevins et de leur élevage dans les enclos n'a pas dépasse 16°C pour les deux années.

Mots-clés: Saumon quinnat, rivière Shuswap, étiquetage à l'aide de fil métallique codé

INTRODUCTION

A wild juvenile chinook salmon coded wire tagging (CWT) program was conducted in the South Thompson River system in 1976, 1979 and 1980. The program was one of several wild chinook CWT programs initiated in the Fraser River watershed to document ocean migration timing, fishery contribution and survival of specific chinook salmon stocks prior to implementation of the Salmonid Enhancement Program. Other wild Fraser River chinook stocks selected for coded wire tagging were the Deadman, Nicola, Chilcotin, and upstream mainstem Fraser River (Tête Jaune Cache) populations.

The CWT method implants a small ($\pm$1 mm) binary coded stainless steel tag in the nose cartilage of juvenile fish. Tagged fish are identified by removal of the adipose fin and subsequently recovered in commercial and sports fishery sampling programs and on the spawning grounds. Data generated from these studies will be used to formulate a management and enhancement plan for Fraser River chinook.

This report summarizes the capture, handling and tagging techniques used, as well as the migratory timing and size and growth of fry in the South Thompson River in 1976 and Shuswap River in 1979 and 1980. Subsequent tag recovery data will be summarized in future reports.

DESCRIPTION OF STUDY AREA

The South Thompson River located in south central British Columbia, drains an area of approximately 16,200 km^2. It originates from Shuswap Lake which in turn is fed by the Adams, Seymour, Eagle, Shuswap and Salmon rivers (Fig. 1). From Shuswap Lake the South Thompson (Little River) flows west for approximately 4 km to Little Shuswap Lake and from Little Shuswap Lake, a further 56 km in a southwesterly direction to its confluence with the North Thompson River at Kamloops. Annual mean discharge at the outlet of Little Shuswap Lake (1915 to 1979) was 283 m^3/sec (Environment Canada 1980). There are no major tributaries downstream of Little Shuswap Lake.

The Shuswap River drains an area of approximately 4700 km^2 and is the largest system discharging into Shuswap Lake. It originates in the Monashee Mountains, flows south to Sugar Lake (upper Shuswap), then southwest before turning north to Mabel Lake (middle Shuswap). From Mabel Lake the Shuswap River flows west then north to Mara Lake (lower Shuswap) and finally Shuswap Lake (Fig. 1). Annual mean discharge at Enderby (1911 to 1979) was 87m^3/sec (Environment Canada 1980).

Climatic conditions are relatively uniform throughout the watershed but show considerable variation during the year. Mean monthly air temperatures may range from -6°C in January to 20°C in July. Recorded extremes in temperature vary from -40°C to 40°C.

Human population in the middle and lower Shuswap valleys has more than doubled in the last 10 years (Government of B.C. 1980), resulting in increased watershed development. Much of the watershed is devoted to agriculture and in the Bessette Creek drainage water withdrawal for irrigation has seriously affected salmon production. Logging is an important industry in the area but as yet no serious deterioration of fish habitat due to poor forest harvesting practices has been demonstrated. The Shuswap Falls hydroelectric/generating dam located on the middle Shuswap River totally obstructs the upstream passage of all salmon.

SALMONID RESOURCE

The South Thompson River system supports chinook (**Oncorhynchus tshawytscha**), coho (**O.kisutch**), pink (**O. gorbuscha**) and sockeye (**O. nerka**). Chinook spawn in the mainstem South Thompson, Little, Adams, Eagle, Salmon and Shuswap rivers. Occasionally

chinook spawning has been observed in smaller tributaries.

Adult chinook first arrive in the system in July and spawn during September and October. The major area of chinook spawning occurs in the mainstem South Thompson at Chase and in the lower Shuswap in a 15 km section downstream from Mable Lake.

Chinook escapement to the South Thompson system increased in the last 30 years from approximately 12,000 fish (1951-1960 mean) to 16,000 fish (1971-1980 mean), with returns to the lower Shuswap River increasing from a mean of approximately 3,600 fish in the 1950's to a mean of approximately 8,500 fish during the 1970's (Table 1). However, chinook escapements to the middle Shuswap River declined during the same 30 year period from an average of about 1100 to 500 fish.

Major coho populations spawn in the Eagle and Salmon rivers, with smaller populations occurring in numerous streams entering Shuswap Lake as well as their tributaries. Coho escapement to the South Thompson system has declined since the 1950's from a mean of approximately 11,000 fish (1951-1960) to a mean of 5,500 fish (1971-1980) (Table 1). This decline is apparent in both the middle and lower Shuswap rivers where the combined coho spawning escapements fell from approximately 3,800 fish during the 1950's to approximately 600 fish during the 1970's.

Sockeye salmon utilize primarily the Adams River and the Little, Seymour and Shuswap rivers. Smaller populations of sockeye spawn in numerous other tributary streams. Sockeye in the Fraser River demonstrate a quadrennially dominant cycle and in dominant years, sockeye escapements in excess of 1.5 million have been reported for the South Thompson system, primarily in the Adams River.

Pink salmon occur in the Fraser River only in odd numbered years. Pink spawning in the Thompson River occurs primarily downstream of Kamloops Lake; however, in recent years pink salmon have been extending their range. While pinks have been observed spawning in the South Thompson River for many years, it is only in the last several cycles that they have been recorded in significant numbers.

Rainbow trout (**Salmo gairdneri**), kokanee (**Oncorhynchus nerka**), carp (**Cyprinus carpio**), redside shiners (**Richardsonius balteatus**), sculpins (**Cottus spp.**), northern squawfish (**Ptychocheilus oregonesis**), suckers (**Catostomus spp.**), and mountain whitefish (**Prosopium williamsoni**) also utilize the Shuswap system.

METHODS

FRY CAPTURE

1976

Beach seining was the principal capture method used during the 1976 program. Other methods, including "Gee" minnow traps (baited with salmon roe) and two different sized purse seines (45.6m x 3.6m and 60.6m x 7.6m; 6.4mm knotless mesh) proved unsuccessful at capturing rearing fish.

Beach seining was conducted during daylight hours (0800 to 1700 hrs.) using 3m x 33m seines constructed of 1.2 cm mesh with a 0.6 cm mesh bunt. Major capture sites were located in Shuswap Lake (S-1, S-2), Little Shuswap Lake (S-3, S-4, S-5) and the South Thompson River (S-6, S-7) (Fig. 2). Shuswap Lake was fished between July 4 and August 12; Little Shuswap Lake was fished between June 28 and August 30; and South Thompson River was fished between August 10 and 30.

On July 16 and August 12, exploratory beach seining and minnow trapping was conducted in Mara Lake (Fig. 1); however, this area was not included in the tagging program (Append. 1).

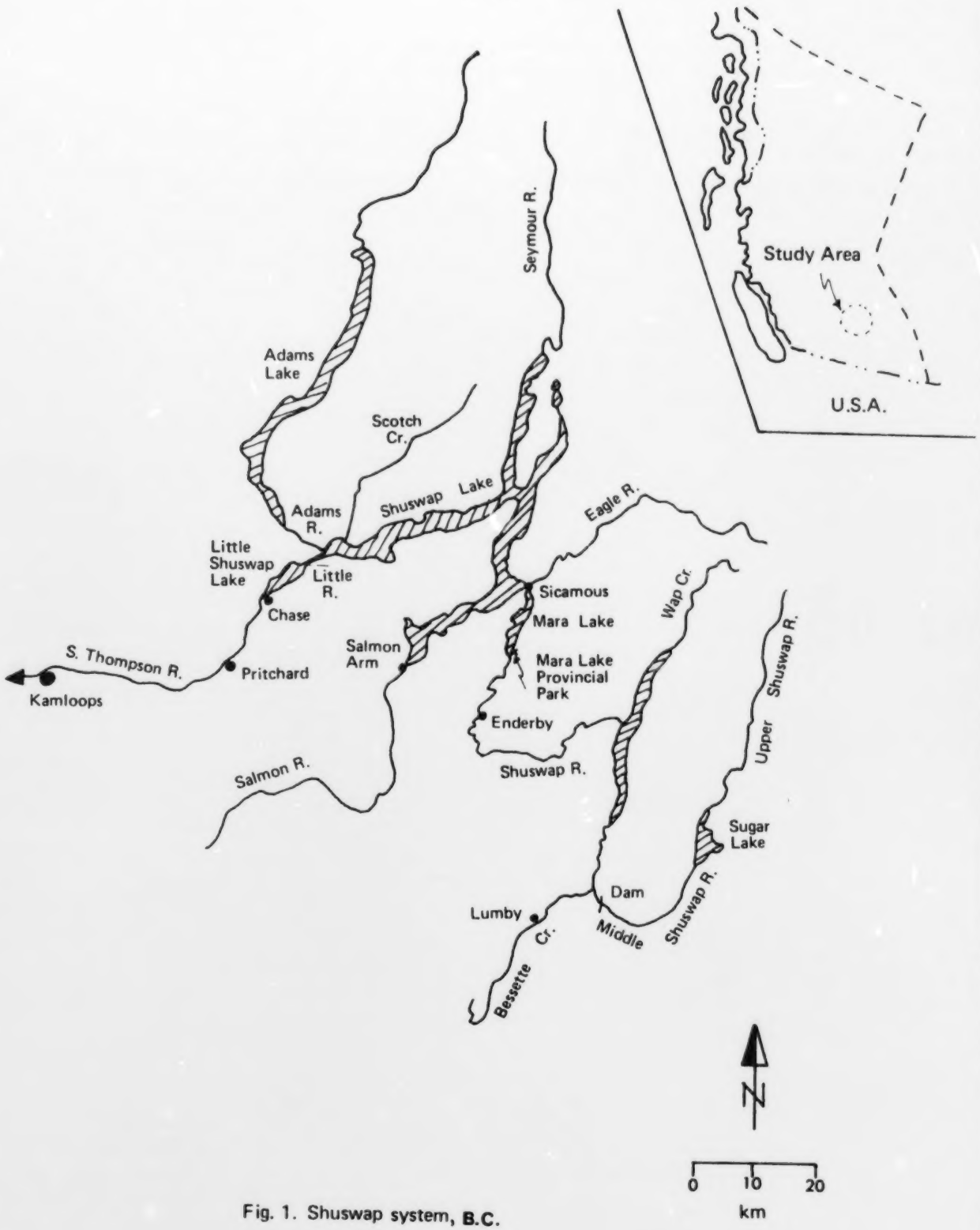

Fig. 1. Shuswap system, B.C.

Table 1. Escapements of chinook, coho and sockeye to the middle and lower Shuswap rivers, and of chinook and coho to the South Thompson system, 1951 - 1980[a].

	Middle Shuswap River			Lower Shuswap River			S.Thompson System	
Year	Chinook	Coho	Sockeye	Chinook	Coho	Sockeye	Chinook	Coho
1951	750	-[b]	-	750	-	3,500	7,325	3,400
1952	1,500	-	-	3,500	-	-	17,400	14,900
1953	750	1,500	-	7,500	3,500	75	24,250	11,000
1954	-	750	-	1,500	-	200	5,650	5,000
1955	1,500	3,500	-	3,500	3,500	25	7,200	23,750
1956	1,500	750	-	3,500	1,500	0	8,250	8,200
1957	1,500	400	-	3,500	750	1,500	12,275	7,750
1958	750	1,500	-	7,500	3,500	7,500	16,850	15,825
1959	750	750	-	1,500	1,500	0	6,475	8,100
1960	750	3,500	-	3,500	1,500	0	11,150	10,925
1961	1,500	3,500	-	3,500	750	400	11,525	14,325
1962	750	1,500	460	3,500	750	31,200	14,325	9,725
1963	750	1,500	-	3,500	750	20	9,575	6,525
1964	750	750	-	3,500	3,500	0	13,425	10,300
1965	400	400	-	1,500	200	580	8,125	11,400
1966	400	400	1,870	3,500	400	24,630	10,775	4,500
1967	1,500	200	25	15,000	200	5,950	22,975	1,700
1968	400	400	0	7,500	400	25	15,725	6,050
1969	500	750	0	7,500	750	1,500	21,325	6,775
1970	750	400	4,560	7,500	400	29,070	18,525	5,100
1971	750	400	210	7,500	75	6,120	12,625	4,938
1972	300	400	0	4,500	300	200	12,350	6,904
1973	400	500	0	9,000	250	7,500	16,800	4,774
1974	600	500	3,060	10,000	100	86,400	17,725	7,155
1975	600	250	25	17,500	100	11,650	27,325	4,090
1976	400	60	0	2,500	40	80	5,300	2,801
1977	550	594	30	9,500	100	7,500	20,496	6,385
1978	350	350	10,890	10,400	300	187,170	17,320	5,895
1979	500	500	0	10,000	300	10,090	18,860	7,538
1980	500	550	0	4,000	350	0	8,910	4,951
Mean								
1951-60	1,083	1,581	-	3,625	2,250	-	11,683	10,885
1961-70	770	980	-	5,650	810	-	14,630	7,640
1971-80	495	410	-	8,490	192	-	15,771	5,543
1976-80	460	411	-	7,280	218	-	14,177	5,514

[a] From: Fraser et al. (1982, in prep.).
[b] No record.

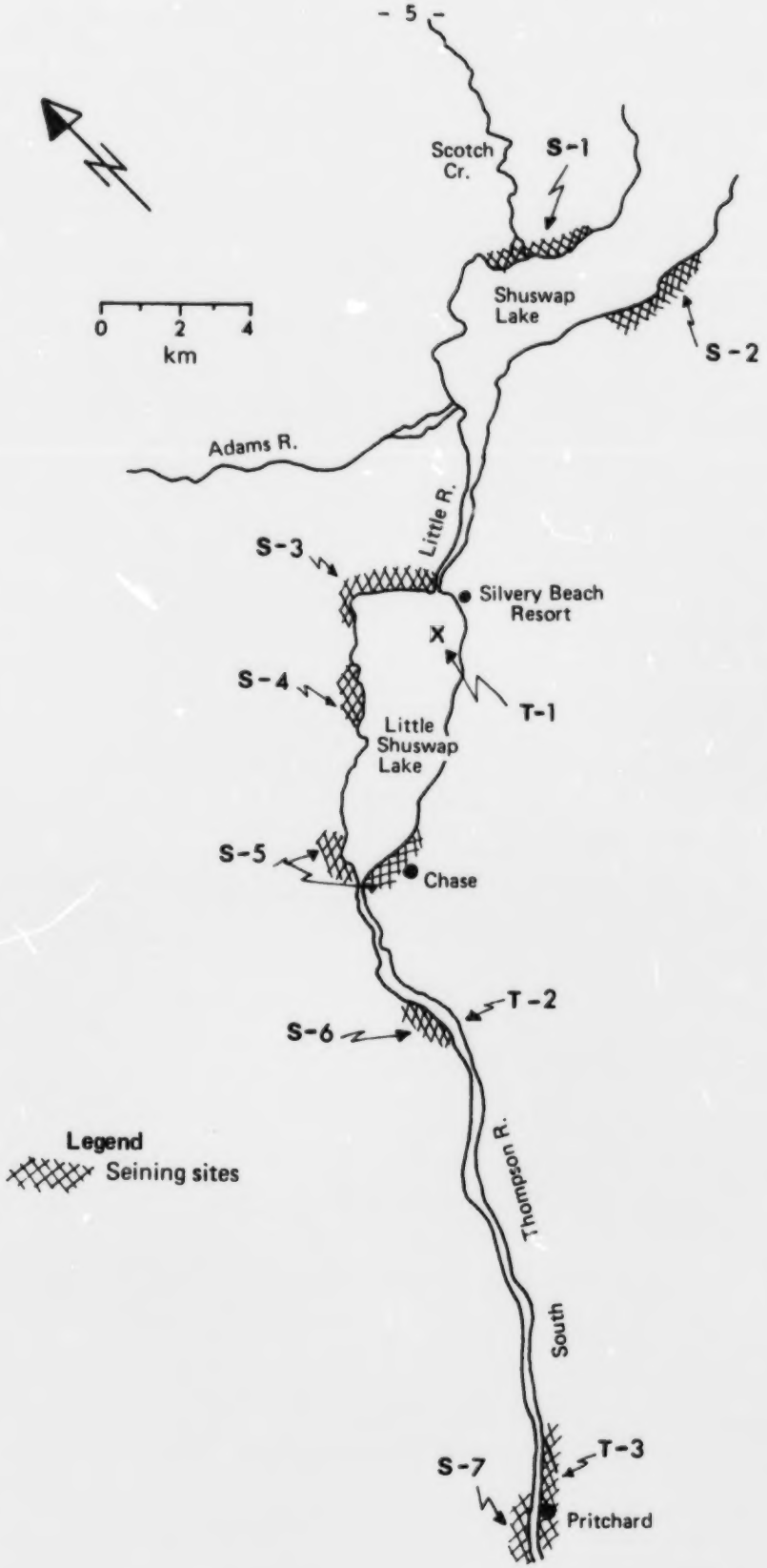

Fig. 2. Location of seining sites (S) and tagging sites (T), Shuswap system, 1976.

Captured fish were enumerated and sorted by size and species either on site or at the tagging location and fry from different capture locations were held separately at the tagging site. Chinook fry less than 55 mm fork length and other species of fish caught incidentally, were released untagged.

1979 and 1980

Juvenile chinook were captured in 1979 exclusively with incline plane traps (IPT), while in 1980 beach seines were used when IPT catches declined.

Incline Plane Traps: The IPT site was located on the lower Shuswap River downstream of Cooke Creek (Fig. 3). In 1979, one 4 x 4 (1.2m x 1.2m) and three 2 x 3 (0.6m x 0.9m) traps were employed between April 12 and May 17. In 1980, two 4 x 4 and one 2 x 3 traps were used between April 13 and May 3. The traps were attached to a 1.9 cm dia. steel cable strung approximately 72 m between two trees on either side of the River (Fig. 4).

The traps were generally fished at night (2100 to 0500 hrs.) since initial 24 hr. fishing indicated that maximum fry migration occurred during dark. The smaller 2 x 3 traps were used to determine the most productive capture location across the river and the larger traps were then positioned accordingly. Traps were cleaned of debris and fry were removed one to four times each night, depending on debris accumulation and number of fry captured.

Captured fish were removed from trap boxes using fine mesh nylon dipnets, placed in 23 l plastic pails lined with marquisette netting, and moved to shore for sorting and enumeration. Fry were either counted individually or estimated volumetrically, depending on size of catch. In 1979, captured chinook fry were held from April 13 to 26 in pens in a backwater area, just above the Cooke Creek narrows. The pens measuring 0.9 m x 1.8 m x 0.9 m deep consisted of 4.8 mm marquisette netting strung on ABS pipe frames (Conlin and Tutty 1979). After April 26, in 1979 and throughout the entire 1980 program, captured fry were

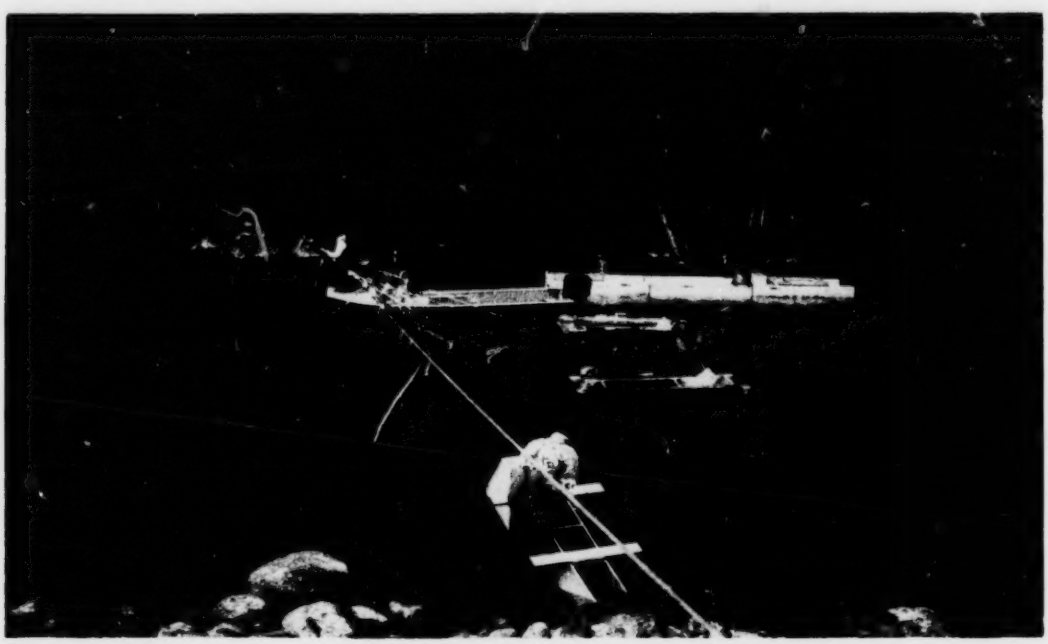

Fig. 4. Positioning of a 4 x 4 and 2 x 3 inclined plane traps across the Lower Shuswap River off Cooke Creek, April, 1979.

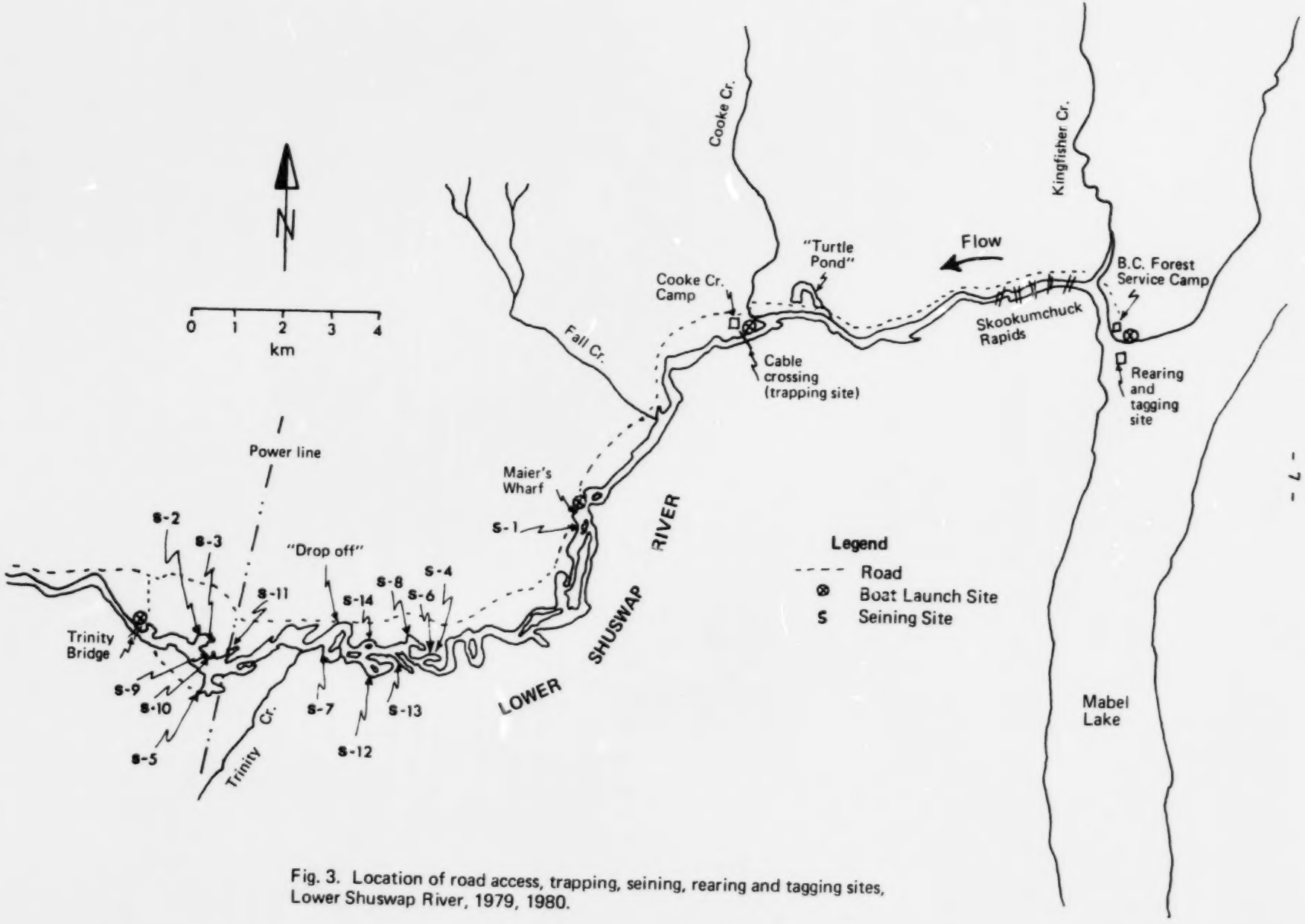

Fig. 3. Location of road access, trapping, seining, rearing and tagging sites, Lower Shuswap River, 1979, 1980.

transported in 45 l plastic garbage cans by truck to a rearing site at Mabel Lake outlet (Fig. 3). Aeration during transport was supplied by compressed O_2 or O-Tabs.

Large numbers of sockeye fry and non-salmonids were also captured in the traps. To separate chinook from sockeye fry, a sorter bag was devised consisting of marquisette netting supported on a round frame, with a 3.2 mm Vexar plastic mesh bottom. This bag was inserted into a 19 l pail filled with water and the unsorted catch was placed in the bag. The fish were then disturbed with sound, light or jarring, and the smaller sockeye swam through the coarse mesh in the bottom of the bag leaving the larger chinook behind.

Beach Seining: Beach seines (1.8m x 15 m and 3 m x 33 m) were constructed of 1.2 cm mesh with a 0.6 cm mesh bunt. Fourteen capture sites were located downstream of the IPT site between Maier's Wharf and Trinity Bridge (Fig. 3 Append. 2). The sites were typically low-lying, flooded backwater areas where large numbers of fry could be observed rearing. Seining was conducted opportunistically, based on fry availability, between May 4 and 23.

Initially, captured fry were removed from the seine and placed into plastic pails, then enumerated while being transferred into separate holding pails. However, this method caused excessive stress and resulted in many deaths. Thereafter, fry were enumerated while being transferred directly from the seine to holding pails.

The holding pails had a 19 l capacity and marquisette mesh lids. Pails containing fish were submerged in the river at seining sites or a "Drop-off" site (Fig. 3) until the end of each day (maximum 8 hours). At the end of each day captured fry were transferred from the instream holding pails to 45 l plastic garbage cans (maximum 5,000 fry per can) and transported by truck to a rearing site at the Mabel Lake outlet. Aeration during transport was supplied by compressed O_2 cylinders or O-Tabs.

FRY REARING

In 1976, fry were tagged on the day of capture or alternately were placed in rearing pens in the stream for tagging the following day. Fry too small for immediate tagging were released.

During 1979 and 1980, all captured chinook fry were reared in instream enclosures at the outlet of Mabel Lake (Fig. 3) until they attained a size large enough for coded wire tagging (minimum 55 mm). Maximum water depth at the rearing site was 2.1 m.

In 1979, the rearing enclosures consisted of four marquisette net pens (2.4 m square) and a floating raceway (1.2 m x 1.2 m x 6.1 m). The net pens were fitted into a floating plywood platform (6.7 m x 6.8 m), flotation for which was provided by 8 styrofoam billets (2.4 m x 3 m x 6 m); 23 kg sand bags weighted down the corners of the pens and provided stabilization. The raceway was semicircular in cross section with side walls constructed of 20 gauge vinyl and end walls of marquisette netting. A log frame provided flotation for the raceway (Fig. 5). Marquisette netting was placed over the enclosures to provide predator protection and prevent escape of fry.

In 1980, only the net pens were used for rearing, with screens (4 mm mesh) substituted for the marquisette lids. In addition, fry captured by beach seines and those fry subjected to anaesthetization for biological sampling were held separately from the fish caught by IPTs to assess the added stress of these procedures on growth.

Fry were fed Oregon Moist Pellet (OMP), (size ranged from 0.8 mm initially to 1.6 mm) according to the OMP Feeding Chart (Append. 3). However, at the start of rearing the food ration exceeded chart rates and fry were fed to

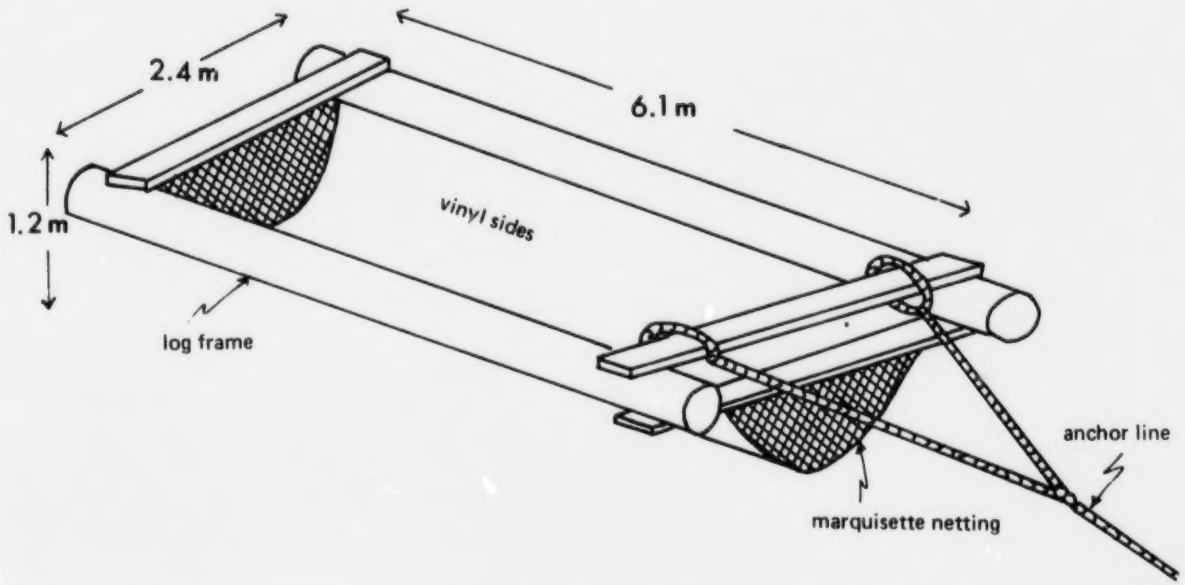

Fig. 5 Floating raceway used for rearing in 1979. (diagrammatic).

satiation 5 times per day to encourage feeding. Thereafter, the fry were sampled weekly in order to calculate growth and food requirements.

Fry additions and mortalities were recorded daily. Fry were observed throughout the rearing period for disease symptoms and all dead fish were examined for causes of death. Pens were checked regularly for holes and brushed daily to remove algae and debris. The raceway used in 1979 required continuous cleaning since the vinyl walls obstructed water circulation and prevented adequate flushing out of wastes.

FRY TAGGING

During 1976, tagging was conducted throughout the seining period between June 20 and August 30. Juveniles captured in Little Shuswap and Shuswap lakes were tagged on a floating platform (7.3 m x 5.5 m) in Little Shuswap Lake (T-1 Fig. 2). The platform was set on pontoons, and contained a tagging table and four holding pens (1.2 m x 1.8 m x 1.8 m deep) made of green 6.4 mm knotless netting (Fig. 6). During August 13 to 30, when catches were large in the South Thompson River, a portable tagging platform was erected on the beach near the fishing sites for immediate fish tagging and release (T-2 and T-3, Fig. 2).

Two injectors were used for tagging; one was set for tagging juveniles 55-70 mm in length (nose-fork), the other for fish greater than 70 mm. Chinook were first anaesthetized with a solution of tricaine methane sulfonate (T.M.S.), then marked with an adipose fin clip and tagged with binary coded wire nose tags (Code 2-15-6). From June 20 to July 17, all marked fry were held for 15 to 72 hours to determine short term tagging related mortality and tag rejection. After July 17, a subsample of approximately 50 fry from each tag lot was retained overnight and the mortality and tag rejection rate of these fry applied to the total tag lot. However,

Fig. 6. Floating tagging platform in Little Shuswap Lake, 1976.

on some occasions no fry were held overnight and in this case, average mortality and tag rejection rates were applied.

During 1979 and 1980, tagging was carried out at the Mabel Lake rearing site from June 13 to 24, 1979, and from June 4 to 10, 1980. Fry were anaesthetized with MS 222, marked with an adipose fin clip, and tagged with binary coded wire nose tags (codes 2-16-25 and 2-16-38 in 1979 and 2-16-1 and 2-17-55 in 1980). Prior to release, all tagged fry were held for several hours in ABS pens to evaluate immediate post-tagging mortality and in most cases, randomly selected lots of tagged fry were held for 24 hours to determine short term tag rejection and delayed mortality (1980 only). When no fry were held for tag rejection and mortality checks, mean values were applied. Fry less than 55 mm were released untagged. In order to encourage the migration of tagged fry out of Mabel Lake, tagged fish were floated downstream in ABS pens a distance of approximately 700 m and released near the outlet of Kingfisher Creek (Fig. 3).

TAG RECAPTURE

In 1979 and 1980, a limited sampling program was conducted after tagged fish were released in an attempt to determine their distribution and to compare the size of pen reared (tagged) and naturally reared (untagged) fry. In 1979, sampling was conducted on July 4 at the "Turtle Pond" (Fig. 3) and on July 5 in Mara Lake off the Mara Lake Provincial Campsite (Fig. 1). In 1980, sampling was conducted between June 11 and July 25 at five sites on the lower Shuswap River and one site on the South Thompson River (Append. 12). Usually one or two seine sets were made at each site using a 3 m x 33 m beach seine.

BIOLOGICAL SAMPLING

During 1976, biological sampling was carried out opportunistically rather

than routinely because of the variability in the number of fry caught at each site. Randomly selected fish from different capture sites were sampled for nose-fork length (± 1 mm, n=50) and scale smears for age determination.

During 1979 and 1980, newly caught fry were subsampled weekly for length (±1 mm, n=30-150), total wet weight (±.05 g, n=50-100), and scale smears. All chinook and coho smolts were measured for nose-fork length and most were sampled for scales. In 1979, trapped sockeye fry were measured for length (±1 mm, n=100) and for total wet weight (±0.05g, n=100).

Pen rearing chinook from each enclosure were generally subsampled weekly: 50 to 100 fry were measured for nose-fork length (±1 mm) and 100 fry were measured for total wet weight (±0.05 g). During tagging, 50 fry per pen were sampled for scale smears.

During the tag recapture program in 1979 and 1980, naturally rearing chinook were sampled for nose-fork length (n >30), total wet weight (n>60) and scale smears.

PHYSICAL SAMPLING

In 1976, water surface temperatures were monitored throughout the program at all seining and tagging sites (Fig. 2); and on August 2, temperature profiles were made in Shuswap and Little Shuswap lakes to a depth of 8 m and 30 m, respectively. Water level data for Little Shuswap Lake at Chase were obtained from the Water Survey of Canada.

During incline plane trapping in 1979 and 1980, water surface temperature, flow and level were recorded nightly. Temperature was obtained with a hand thermometer. Water velocity was measured at trap entrances during alternate fishing days by timing a floating object in 1979, and using a Marsh McBirney portable flow meter in 1980. A permanent water level gauge was established in April 1979, but was washed out on April 30, 1980. After that date, water level estimates were made using a temporary gauge. During fry transport and enumeration, ambient water temperatures were monitored continuously to avoid temperature stress.

During fry pen rearing in 1979, water temperatures in pens were monitored continuously at 1.2 m depth using a Taylor thermograph. In 1980, six sites per pen were measured for temperature (two sites at each of 0.5 m, 1 m and 1.5 m depths) and a mean temperature derived. Water flow through the pens was estimated by timing a floating object in 1979, and using a Marsh McBirney flow meter in 1980. Water level data at the Mabel Lake outlet in 1979 were obtained from the Water Survey of Canada.

RESULTS

FRY CAPTURE

Daily chinook catches for 1976, 1979 and 1980 are listed in Appendices 4 to 7 and are summarized by area in Tables 2 and 3.

1976

In 1976, an estimated 37,519 chinook fry greater than 55 mm were captured between June 28 and August 30. An additional 13,202 fry less than 55 mm were captured and released immediately. Release of undersized fry was common until early July, especially at the south end of Little Shuswap Lake (S-5). After July 15 most fry were of taggable size.

Of the retained chinook, 27,577 (74%) were captured in Little Shuswap Lake, with the north and south ends and northwest beach areas contributing 31%, 35% and 8%, respectively, to the total; 1,682 (5%) were captured in Shuswap

Table 2. Estimated catch of chinook fry by beach-seine in the Shuswap - South Thompson River system, June to August, 1976.

Seining site	Seining period[a]	No. retained (>55mm)	No. released (<55mm)	% of retained
Shuswap Lake (S-1 and 2)	Jul. 4-Jul. 31	1,682	730	4.5%
Little Shuswap Lake				
N. End (S-3)	Jul. 3-Aug. 28	11,436	662	30.5%
N.W. Beach (S-4)	Jul. 15-Aug. 24	3,166	- [b]	8.4%
S. End (S-5)	Jun. 28-Aug. 29	12,975	11,708	34.6%
Sub-total	Jun. 28-Aug. 29	27,577	12,370	73.5%
South Thompson River				
(S-6)	Aug. 10-Aug. 30	6,057	86	16.1%
(S-7)	Aug. 17-Aug. 27	2,203	16	5.9%
Sub-total	Aug. 10-Aug. 30	8,260	102	22.0%
Total	Jun. 28-Aug. 30	37,519[c]	13,202+	100.0%

[a] Seining period not continuous.

[b] No data.

[c] Underestimated due to bulk counting; mortality and tagging data give a total of 39,203 fry.

Lake; and 8,260 (22%) were captured in South Thompson River, mostly below Chase at Site 6 (Fig. 2, Table 2).

Chinook catch per seine set in Little Shuswap Lake declined from a high of 226 fish on June 28 to only a few fish by late August (Append. 4a). In Shuswap Lake where fishing was conducted only during July, catch per set ranged from 66 to 7 fish and also declined with time. In South Thompson River where fishing occurred only in August, catch per set ranged from 43 fish in mid-August to less than 10 fish by the end of August at Site 6, and from 22 fish to less than 10 fish at Site 7 over the same period. Scale samples indicated that all captured chinook were young of the year.

1979

In 1979, an estimated 170,692 chinook fry (an additional 2,132 died in the traps) were captured by incline plane trap between April 12 to May 17 (Table 3). This number was later corrected to 153,238 based on the more accurate rearing mortality and tagging inventory (Table 4). Peak captures occurred during April 26 to May 4, when over 50%

of the total catch was taken (Fig. 7).

1980

In 1980, an estimated 114,136 chinook fry (an additional 2,057 died during capture) were caught in the Lower Shuswap River. Of these fry, 66,153 (58%) were captured with IPTs between April 13 to May 3, and 47,983 (42%) were caught with beach seines between May 4 and 23 (Table 3). However, as a result of fry losses through damaged rearing pens, the more accurate rearing mortality and tagging inventory could account for only 64,733 fry (Table 5). Peak trap catches in 1980 occurred between April 14 to 23, when over 80% of the total catch was taken (Fig. 8). Highest catches during beach seining were made in early May at Site 1 (40% of total beach seine catch) (Append. 7). The catch per unit effort declined significantly after May 22 and the seining program was terminated.

Daily catches of fish other than chinook fry are listed in Appendix 8 and available data on salmonid juveniles other than chinook fry (approximate catch, size and age) are presented in Append. 9. During the 1976 seining program, sockeye fry and smolts, coho fry and smolts, carp, rainbow trout, redside shiners, sculpins, squawfish, suckers and whitefish were caught incidentally to chinook fry. In 1979 and 1980, incidental catches of fish other than chinook fry included all of the above, plus chinook smolts, Dolly Varden and dace.

FRY REARING

In 1979 the total number of chinook fry reared in pens was 153,238 (based on the 151,306 chinook fry from tagging inventory and the 1,932 pre-tagging mortalities) (Table 4). The pretagging mortality rate was 1.3%. The density of fry in each pen varied throughout the rearing period as fry were added and redistributed among pens to balance their loading. The maximum number of fry in each enclosure at any time was as follows:

Enclosure	Maximum No. of Fry	Date
Pen 1	55,885	May 15
Pen 2	59,753	May 6
Pen 3	33,984	June 7
Pen 4	51,016	May 12
Raceway	33,877	June 6

Feed ration, expressed as percent of the total fry weight per feeding generally ranged from 0.7% at start to 1.8% at end of rearing. Total OMP fed was 639.3 kg (Table 4).

In 1980, an estimated 107,428 chinook fry were penned. However, unquantifiable losses of fry through holes in net pens occurred and only 64,733 fry could be accounted for after tagging. This large discrepency precludes the determination of fry densities in rearing pens.

Feed ration, expressed as percent of total fry weight per feeding, generally ranged from 0.7% at start to 2.2% at end of rearing; total weight of OMP fed was 276.9 kg (Table 5).

FRY TAGGING

In 1976, 35,375 fry were tagged and an estimated 19,034 were released with adipose fin clips and coded wire nose tags (CWT's) (code 2-15-6) (Table 6). Corrections made for delayed tag loss and tagging related mortality are summarized in Append. 10. Mean tag rejection was estimated at 3.8% (range 0 to 20) and overnight mortality ranged from 3% to 91%. An estimated 15,578 chinook died as a result of the tagging operation. Most of the recently dead chinook exhibited no obvious injuries; however, some had light coloured blotches on their bodies and slight to severe scale loss. There appeared to be no correlation between fish size and mortality rate (i.e. fish of all sizes were similarly represented among the

Table 3. Estimated number of chinook fry caught in the lower Shuswap River, 1979, 1980.

Method used	Trapping interval	Total catch	
		No. live[a]	No. dead
	1979		
4x4 trap	Apr. 12-May 17	84,509 (50%)	1,470
2x3 trap #1	Apr. 17-May 17	34,944 (20%)	290
2x3 trap #2	Apr. 13-May 17	36,125 (21%)	344
2x3 trap (IPSFC)	May 1-May 17	15,114 (9%)	28
Total	Apr. 12-May 17	170,692 (100%)	2,132
	1980		
4x4 trap #1	Apr. 13-May 3	31,092 (27%)	500
4x4 trap #2	Apr. 13-May 3	32,142 (28%)	849
2x3 trap (IPSFC)	Apr. 18-Apr. 29	2,919 (3%)	4
Total	Apr. 13-May 3	66,153 (58%)	1,353
Beach seine[b]	May 4-May 23	47,983 (42%)	704
Total (trap & seine)	Apr. 13-May 23	114,136 (100%)	2,057

[a] Number in parenthesis gives % of total trapped.

[b] Includes limited dip net and pole seine catches.

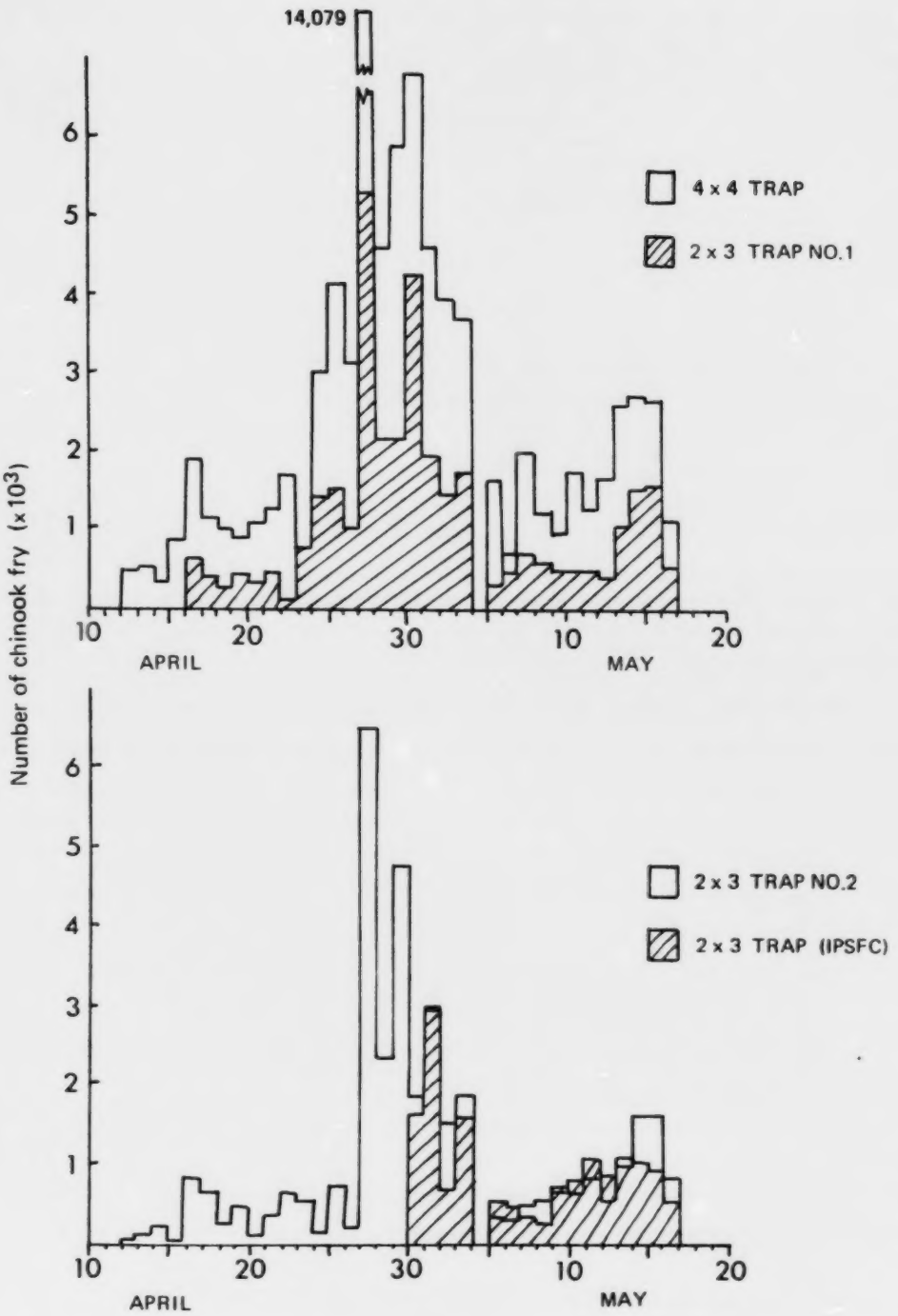

Fig. 7. Daily chinook fry catches (live and dead) per trap, Lower Shuswap River, April – May, 1979.

Table 4. Chinook pen rearing summary, pens 1 to 4 and raceway, Mabel Lake, 1979[a].

Pen No.	Rearing interval	Rearing T(°C)	No. surviving reared fry[b]	Rearing mortality	Total OMP fed (kg)
1	Apr. 26-Jun. 16	5-14°C	33,744 (33,660)	349	148.6
2	Apr. 26-Jun. 20	5-15°C	30,614 (33,673)	538	156.3
3	May 17-Jun. 19	11-15°C	32,147 (33,886)	153	99.3
4	Apr. 28-Jun. 19	6-15°C	28,574 (33,683)	477	162.2
Raceway	Jun. 6-Jun. 20	12-15°C	26,227 (33,485)	415	72.9
Total	Apr. 26-Jun. 20	5-15°C	151,306 (168,387)	1,932[c]	639.3

[a] Fry were redistributed among pens throughout rearing; final numbers are given.
[b] Actual total fry from tagging inventory, including undersized, untagged fry (less accurate initial fry loading estimate in parenthesis).
[c] Includes 530 live tagged fry retained for disease checks.

Table 5. Chinook pen rearing summary, pens 1 to 4, Mabel Lake, 1980.

Pen No.	Rearing interval	Rearing T(°C)	No. surviving reared fry[a]	Rearing mortality	Total OMP fed (kg)
1	Apr. 29-Jun. 9	8-12°C	5,784 (12,240)	99	28.8
2	May 5-Jun. 9	10-12°C	7,086 (30,579)	2,120	59.5
3	Apr. 20-Jun. 8	5-11°C	12,843 (28,401)	1,476	85.95
4	Apr. 15-Jun. 6	5-12°C	35,144 (36,208)	181	102.6
Total	Apr. 15-Jun. 9	5-12°C	60,857 (107,428)	3,876	276.9

[a] Actual total fry from tagging inventory, including undersized, untagged fry (less accurate initial fry loading estimate in parenthesis; large discrepancy resulting from fry escaping through damaged pens).

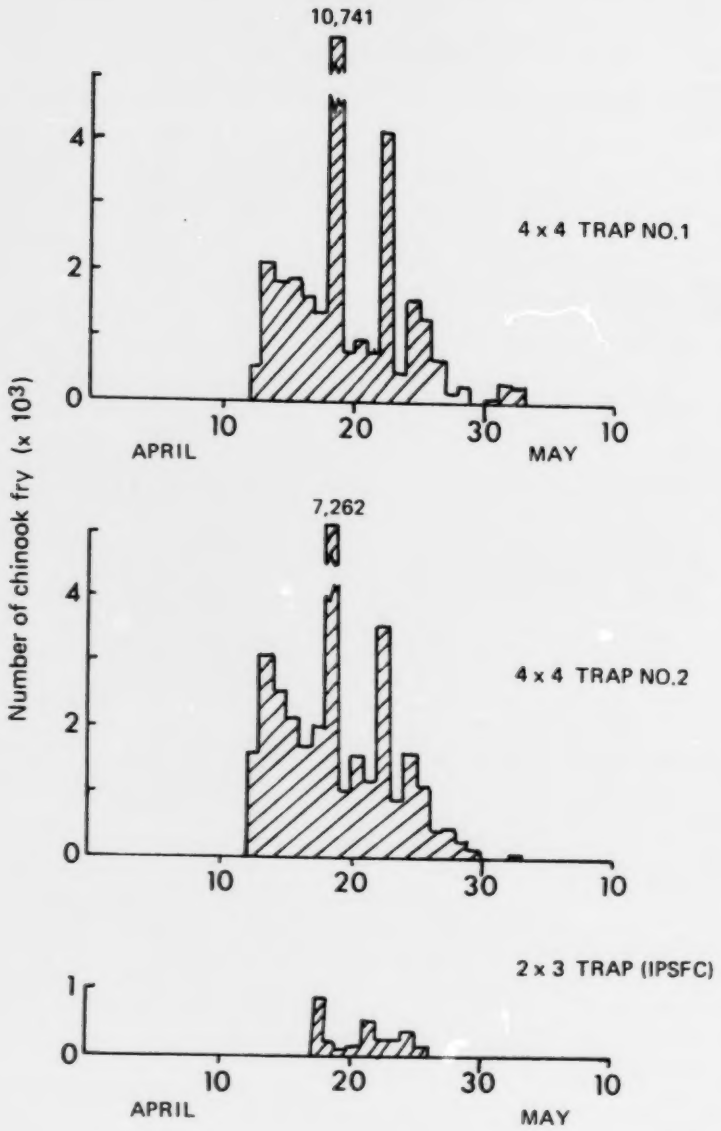

Fig. 8. Daily chinook fry catches (live and dead) per trap, Lower Shuswap River, April – May, 1980.

dead).

In 1979, 142,745 fry were clipped and tagged and an estimated 141,502 chinook were released with adipose fin clips and CWT's (122,797 fry with code 2-16-25 and 18,705 fry with code 2-16-38) (Table 6). Corrections made for delayed tag loss are summarized in Append. 11. Mean tag rejection was 0.7%. An additional 7,961 undersized fry (less than 55 mm) were released untagged. A slight outbreak of columnaris occurred during the tagging operation. The fish were treated with Terramycin (mixed in feed) and appeared to respond well by release time. Live samples of 530 pen rearing fry subsampled on June 20 and 22, and 15 naturally rearing fry collected at Mabel Lake outlet on June 25, were examined by the DFO Diagnostic Service in Nanaimo, but no signs of infection were found.

In 1980, 60,394 fry were clipped and tagged and an estimated 57,842 chinook were released with adipose fin clips and CWT's (45,440 with code 2-16-1 and 12,402 with code 2-17-55) (Table 6). Corrections made for delayed tag loss and tagging related mortality are summarized in Append. 12. Mean tag rejection was 2.5% and overnight mortality was 1.7%. An additional 391 undersized fry were released untagged. The fry were generally healthy throughout the rearing period, except for a limited mortality attributed to handling stress, cannibalism and "tail rot". During June 10 tagging, several dead fry appeared to have advanced symptoms of columnaris. As a precaution, the remaining fry were administerd Terramycin in their feed.

TAG RECAPTURE

In 1979, a total of 4 tagged chinook were recaptured during the July 4 to 5 sampling program (Append. 13). Three tagged fry were among 92 chinook caught at the "Turtle Pond" on July 4 and one was among 73 chinook caught in Mara Lake on July 5.

In 1980, a total of 6 tagged chinook were recaptured (Append. 13). Two tagged chinook were among 128 chinook caught at the "Turtle Pond" on June 18 and one was among 611 chinook caught in Mara Lake on June 19. Also on June 19, three tagged chinook were among 90 captured at Mable Lake outlet in the vicinity of the tagging site. It is believed the latter tagged fry were from a holding pen that was accidentally overturned during tagging rather than fry that swam back upstream to the lake.

Recapture data were insufficient to compare the size of untagged (naturally reared) and tagged (pen reared) chinook (Append. 13). However, tagged chinook were generally larger.

BIOLOGICAL SAMPLING

Biological sampling data are summarized in Tables 7, 8 and 9. In 1976, chinook fry captured with beach seines in Little Shuswap Lake increased in size from approximately 41 mm in June to approximately 89 mm by late August. Limited sampling occurred in Shuswap Lake where in late July, fry averaged 76.6 mm. Fry captured in the South Thompson River in August ranged in size from approximately 80 mm to 105 mm (Table 7). Among the latter fish, those captured at site 6 were somewhat larger (mean length 87-105 mm) than fry from the downstream site 7 (mean length 80-87 mm) (Table 9). Chinook juveniles captured on July 16 in Mara Lake (Fig. 1) had a mean length range of 57-61 mm (Append. 1).

Newly emergent chinook fry captured in the Lower Shuswap River in April 1979 and 1980, measured approximately 38 mm (Tables 8 and 9). The daily specific % growth rate during pen rearing was calculated as follows:

$$\frac{\ln b - \ln a}{t_f - t_f} \times 100\%$$

where a and b are initial and final sizes respectively, and t is time in

Table 6. Chinook fry tagging summary, 1976, 1979, 1980.

Date		Code	# Tagged	Mean 24 hr. Tag rejection (range)	Mean 24 hr. mortality (range)	Estimated Number Released with CWT	Estimated Number Released without CWT	Mean size (mm)
20/6-30/8	1976	2-15- 6	35,375	3.8% (0-20%)	54% (3-91%)	19,034	763	55-105
13/6-24/6	1979	2-16-25	123,922	0.7% (0.4-1.6%)	-	122,797	1,125	61.3
21/6-24/6	1979	2-16-38	18,823		-	18,705	118	58.8
4/6- 9/6	1980	2-16- 1	47,621	2.5% (0.5-7.8%)	1.7% (0-14.7%)	45,440	1,200	60.4
10/6	1980	2-17-55	12,773			12,402	283	59.6

days. A condition coefficient (K) (Nikolskii 1963) was used to indicate the general physical condition of fry. This factor was also considered to be a suitable condition indicator for naturally rearing fry since over 90% of the catch were buttoned up at all times. The equation used was:

$$K = \frac{W \times 100}{L^3}$$ where W is fish weight (g) and L is fish length (cm).

In 1979, the overall mean increase in size of pen reared fry during April 26 to June 15 was from 38.1 mm to 60.8 mm and from 0.48 g to 2.74 g (Fig. 9, Table 8). Based on these data, the daily growth rate of pen rearing chinook was 0.93% by length and 3.48% by weight. Condition factor (K) increased from 0.9 in April to 1.2 in June (Table 8). The above size means were derived from growth data means for individual rearing enclosures (Append. 14) which due to fry redistributions among pens during rearing, did not hold distinct fry populations.

Comparison of the May 1979 sizes of naturally rearing and pen rearing chinook fry, shows the former fry were consistently smaller (naturally rearing fry: 37.6 mm - 38.6 mm, 0.41 g - 0.54 g vs pen rearing fry: 39.5 mm - 44.3 mm, 0.47 g -1.8 g) (Table 8). Considerably larger naturally rearing fry, but still smaller than released pen reared fry were captured in July further downstream from the trapping site (52.8 mm and 58.8 mm, 1.63 g and 1.86 g) (Table 8). Comparison of naturally reared and pen reared fry scales in 1979 showed that freshwater circuli counts were similar in both groups (range: 7-9), but that scales of pen reared fry were slightly larger with wider spacings between circuli.

During 1980, the overall mean increase in size of pen reared fry during April 21 to June 9, was from 38.3 mm to 60.2 mm and from 0.46 g to 2.46 g (Fig. 9, Table 9). Based on these data, the daily growth rate of pen rearing chinook was 0.90% by length and 3.35% by weight. Condition factor (K) increased from 0.8 in April to 1.1 in June (Table 9). Fry growth per rearing pen is given in Append. 15.

As in 1979, naturally rearing chinook fry in 1980 were smaller than pen rearing fry throughout the rearing period, with the size difference increasing as the rearing progressed (Fig. 9, Table 9). Naturally rearing chinook increased from 38.1 mm and 0.50 g on April 14 to 57.1 mm and 2.29 g by June 18 (Table 9). Naturally rearing chinook captured later in the season (July 25) in the South Thompson River were considerably larger (77.9 mm, 2.90 g) than the earlier captured fish (Table 9).

Table 7. Mean length (mm) of juvenile chinook from Shuswap Lake, Little Shuswap Lake, and South Thompson River seining sites (S), June-August, 1976 (sample size is given in parenthesis).

	Shuswap Lake	Little Shuswap Lake				South Thompson River	
	S-1&2	S-3	S-5	S-4	Other	S-6	S-7
Jun. 10		41.5 (166)					
11			41.4 (100)				
20		43.3 (73)					
Jul. 2			59.8 (100)				
12					66.1 (60)		
15					75.6 (50)		
19		75.2 (46)	65.2 (103)				
30		74.8 (100)			77.1 (50)		
31	76.6 (100)						
Aug. 1			71.2 (50)				
3				75.9 (51)			
9			84.4 (50)				
10						86.5 (50)	
13		79.9 (50)		83.9 (50)		88.0 (50)	
14						104.6 (50)	
18							79.8 (75)
23		88.8 (50)					
26							86.5 (50)
29						93.6 (50)	

Table 8. Mean length (L), weight (W) and condition factor (K)[a] of naturally rearing and pen rearing chinook fry, lower Shuswap system, 1979 (sample size is given in parenthesis[b]).

Date	Capture site	Naturally rearing fry L±S.E. (mm)		W(g)	K		Pen rearing fry[c] L(mm)		W(g)	K
Apr. 13	Trapping site[d]	38.0±0.15	(50)	0.59	1.08		-[e]	-	-	-
20	"	38.8±0.21	(50)	0.54	0.98		-	-	-	-
26	"	-	-	-	-		38.1	(100)	0.48	0.87
28	"	38.0±0.14	(100)	0.47	0.86		-	-	-	-
May 6	"	38.1±0.14	(100)	0.41	0.74	(May)	39.5	(100)	0.47	0.76
11	"	37.8±0.13	(100)	0.48	0.89		39.3	(300)	0.61	1.00
17	"	37.6±0.17	(100)	0.44	0.83		40.7	(300)	0.67	0.99
18	"	-	-	-	-		-	-	-	-
25	"	-	-	-	-		44.3	(400)	1.08	1.24
31	"Turtle Pond"[f]	38.6±0.24	(150)	0.54	0.94		-	-	-	-
Jun. 1	-	-	-	-	-		48.7	(400)	1.42	1.23
8	-	-	-	-	-		44.7	(500)	2.17	1.26
15	-	-	-	-	-		60.8	(500)	2.74	1.22
July 4	"Turtle Pond"	58.8±1.00	(69)[g]	1.86	0.91		-	-	-	-
5	Mara Lake	52.8±0.73	(63)[h]	1.63	1.11		-	-	-	-

[a] $K = \frac{W(g) \times 100}{L^3 (cm)}$

[b] Same sample size applies to L columns.

[c] Overall length and weight means are averages of enclosure means (Append. 8).

[d] Off Cooke Creek.

[e] No data.

[f] See Fig. 3 for location.

[g] Three additional adipose clipped chinook captured (59.7±2.3).

[h] One additional adipose clipped chinook captured (60 mm).

Table 9. Mean length (L), weight (W) and condition factor (K)[a] of newly caught (naturally rearing) and pen rearing chinook fry, lower Shuswap system, 1980 (sample size is given in parenthesis).

Date	Capture site[b]	Naturally rearing fry				Pen rearing fry[d]				
		L±1 S.E. (mm)		W(g)[c]	K	L(mm)		W(g)		K
Apr. 14	Trapping site	38.1±0.21	(50)	0.50	0.90	-[e]		-	-	-
21	"	38.5±0.21	(50)	0.47	0.82	38.3	(100)	0.46	(200)	0.82
28	"	37.6±0.23	(40)	0.54	1.02	38.7	(100)	0.46	(200)	0.79
May 4	S-1	38.3±0.25	(50)	0.41	0.73	-	-	-	-	-
5	-	- -	-	-		40.4	(100)	0.64	(200)	0.97
12	S-6	40.0±0.34	(50)	0.55	0.86	41.9	(200)	0.75	(400)	1.02
19	S-11	44.5±0.45	(50)	0.81	0.92	45.9	(200)	1.02	(400)	1.05
26	S-12	47.8±0.52	(50)	1.17	1.07	52.0	(200)	1.48	(400)	1.05
29	-	- -	-	-		56.7	(100)	2.09	(200)	1.15
Jun. 2	-	- -	-	-		57.6	(200)	2.25	(400)	1.18
3	S-12	51.8±0.73	(50)	1.46	1.05	-	-	-	-	-
6	-	- -	-	-		61.0	(50)	2.27	(100)	1.00
9	-	- -	-	-		60.2	(150)	2.46	(300)	1.13
11	S-12	51.1±0.69	(50)	1.33	1.00	-	-	-	-	-
18	S-12	57.1±0.78	(50)	2.29	1.23	-	-	-	-	-
18	Mabel L. outlet	54.2±0.99	(50)	1.74	1.09	-	-	-	-	-
18	"Turtle Pond"	53.6±1.01	(31)	-	-		-	-	-	-
18	S-9	53.9±0.81	(50)	1.69	1.08	-	-	-	-	-
19	Mara Lake	53.2±0.68	(50)	1.65	1.10	-	-	-	-	-
19	Mabel L. outlet	60.7±0.75	(50)	2.51	1.12	-	-	-	-	-
Jul. 25	S-6[f]	77.9±0.99	(42)	2.90	0.61	-	-	-	-	-

[a] $K = \frac{W(g) \times 100}{L^3 (cm)}$

[b] See Fig. 3 for site location.

[c] Mean weight based on total weight of an aggregate of ~90 to 100 fry.

[d] Overall length and weight means are averages of pen means (Append. 9).

[e] No data.

[f] On South Thompson River (Fig. 2).

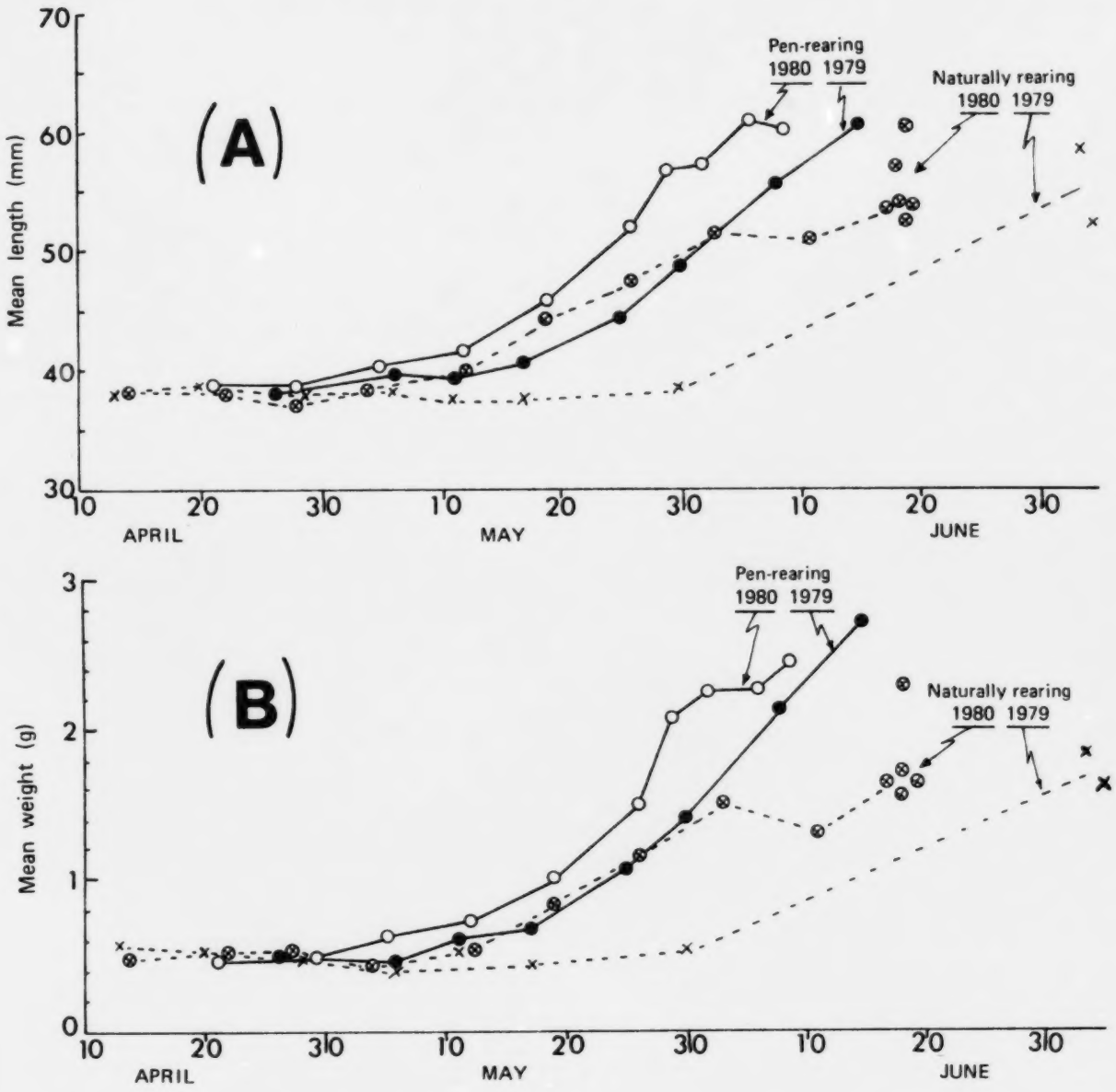

Fig. 9. Mean length (A) and weight (B) of naturally rearing and pen-rearing chinook juveniles, Lower Shuswap River, 1979, 1980.

PHYSICAL SAMPLING

In 1976, water temperatures at the Shuswap Lake seining site (S-1) increased during July from 16.0°C to 20.0°C; water temperatures at the Little Shuswap Lake seining sites (S-3, 4 and 5) increased from a low of 10.0°C in late June to a high of 19.5°C in mid-August (Append. 16a). Water temperature depth profiles made in the above two lakes on August 2, 1976 ranged from 14.8°C to 18.5°C at the surface, depending on the station, and a decrease in temperature with depth to a low of 5.0°C at 30.5 m depth in Shuswap Lake (Append. 16b). Water temperatures at the South Thompson River seining sites (S-7 and 8) declined during August from 18.0°C to 15.0°C (Append. 16c).

Surface water temperatures in 1976 at the Little Shuswap Lake tagging site (T-1) increased from a low of 12.0°C in late June and early July to a high of 17.0°C in mid-July and August; water temperatures at the South Thompson River tagging sites (T-2 and 3) remained uniform during August at 16°C to 17.5°C (Append. 17). Water level in Little Shuswap Lake at Chase rose from a low of 1.5 m in early May to a high of 5.1 m in early June, then dropped gradually during July and August to below 2 m (Fig. 10).

During fry capture in 1979, surface water temperature at the incline plane trapping site off Cooke Creek increased from 2.8°C in April to 10.0°C in mid-May, and water level rose from 0.3 m to 1.0 m during that time (Fig. 11, Append. 18). Water velocity at trap entrances ranged from 46 cm/sec to 183 cm/sec (Append. 18).

During pen rearing in 1979, water temperature at the Mabel Lake rearing site increased from 5.0°C in April to 17.0°C on June 11 (Fig. 12, Append. 19). Water level rose from 1.0 m to a maximum of 2.5 m during that time (Append. 20). No consistent data on water flow through pens were available that year. Tagging temperatures in June, 1979 ranged from 13.5°C to 15.5°C (Append. 19).

In 1980, surface water temperatures at the incline plane trapping site increased from 5.0°C in April to 9.0°C by May 3, and water level rose from 0.2 m to 1.3 m during that time (Fig. 11, Append. 21). Water velocity at trap entrances ranged from 30 cm/sec to 180 cm/sec (Append. 21). During beach seining in 1980 (May 4-23), surface water temperatures at the 14 sites on the Lower Shuswap River ranged from 9.0°C to 16.0°C (Fig. 11, Append. 7). From early June to late July of 1980, when post-tagging seining was conducted, water temperatures ranged from 10.5°C to 22.5°C (Append. 13).

During pen rearing in 1980, water temperatures at the Mabel Lake rearing site increased from 5.0°C in April to 12.0°C in June (Fig. 12, Append. 19). Water level rose from 1.0 m in April to 2.5 m by mid May (Append. 22). Mean water flows through pens ranged from 1.4 cm/sec to 14 cm/sec, with an overall mean of 6.1 cm/sec (Append. 22). Tagging temperatures in June, 1980 ranged from 11.5°C to 12.5°C (Append. 19).

DISCUSSION

MIGRATION TIMING

Based on the incline plane trap catches in 1979 and 1980, peak fry emergence and initial downstream distribution in the lower Shuswap River was estimated to occur from late April to early May in 1979, and during mid-April in 1980. Warmer river temperatures in 1980, compared to 1979 (Fig. 11), may explain the earlier migration timing in 1980. Previous studies in the area suggest a similar migration timing (DFO, unpublished data). The 1979 and 1980 migration timing estimates are biased to some extent by the number of days fished each year, the amount of time spent fishing each day, and by trapping efficiency which was affected considerably by

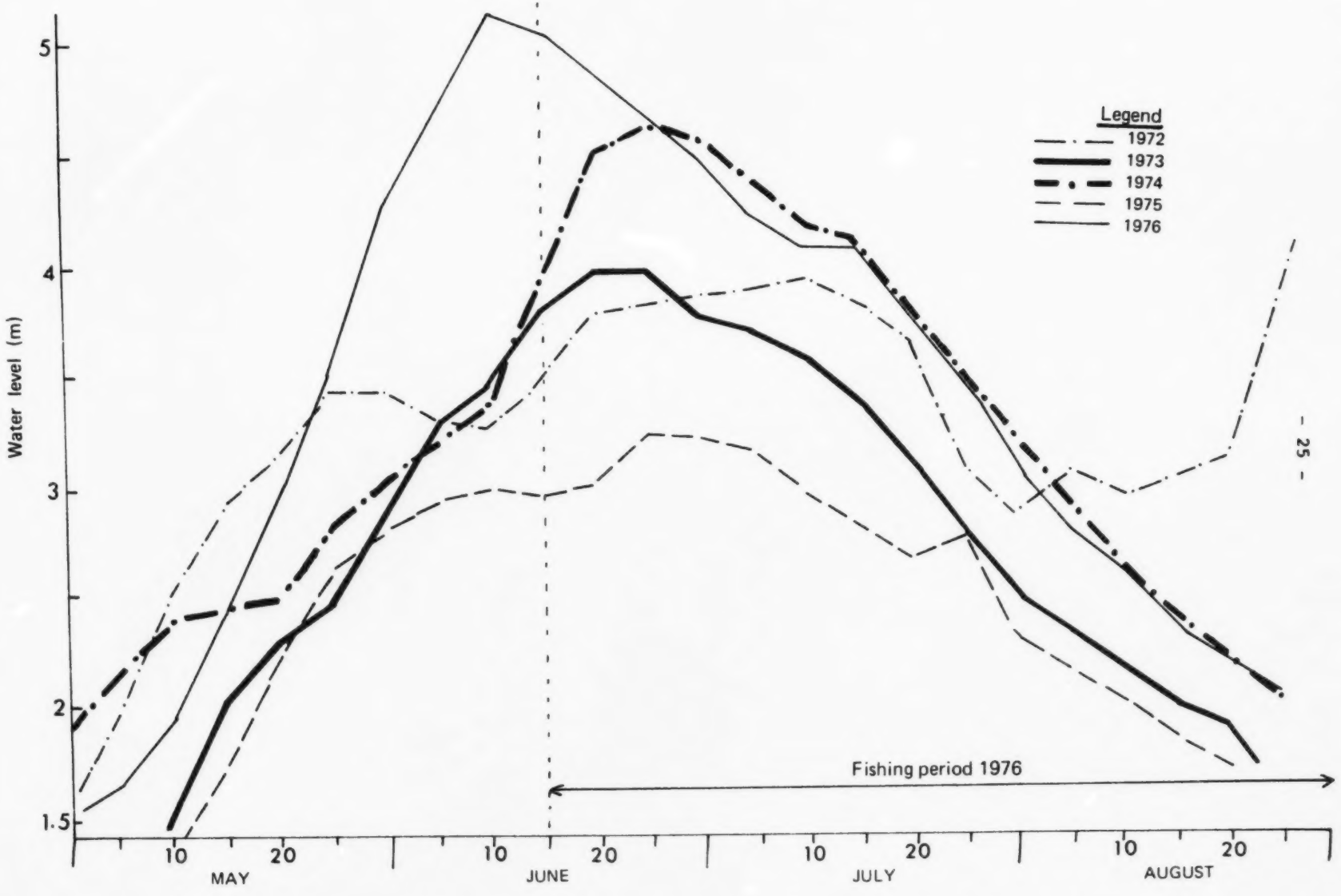

Fig. 10. Water level (five day means) in Little Shuswap Lake, May – August, 1972 – 1976 (from Water Survey of Canada).

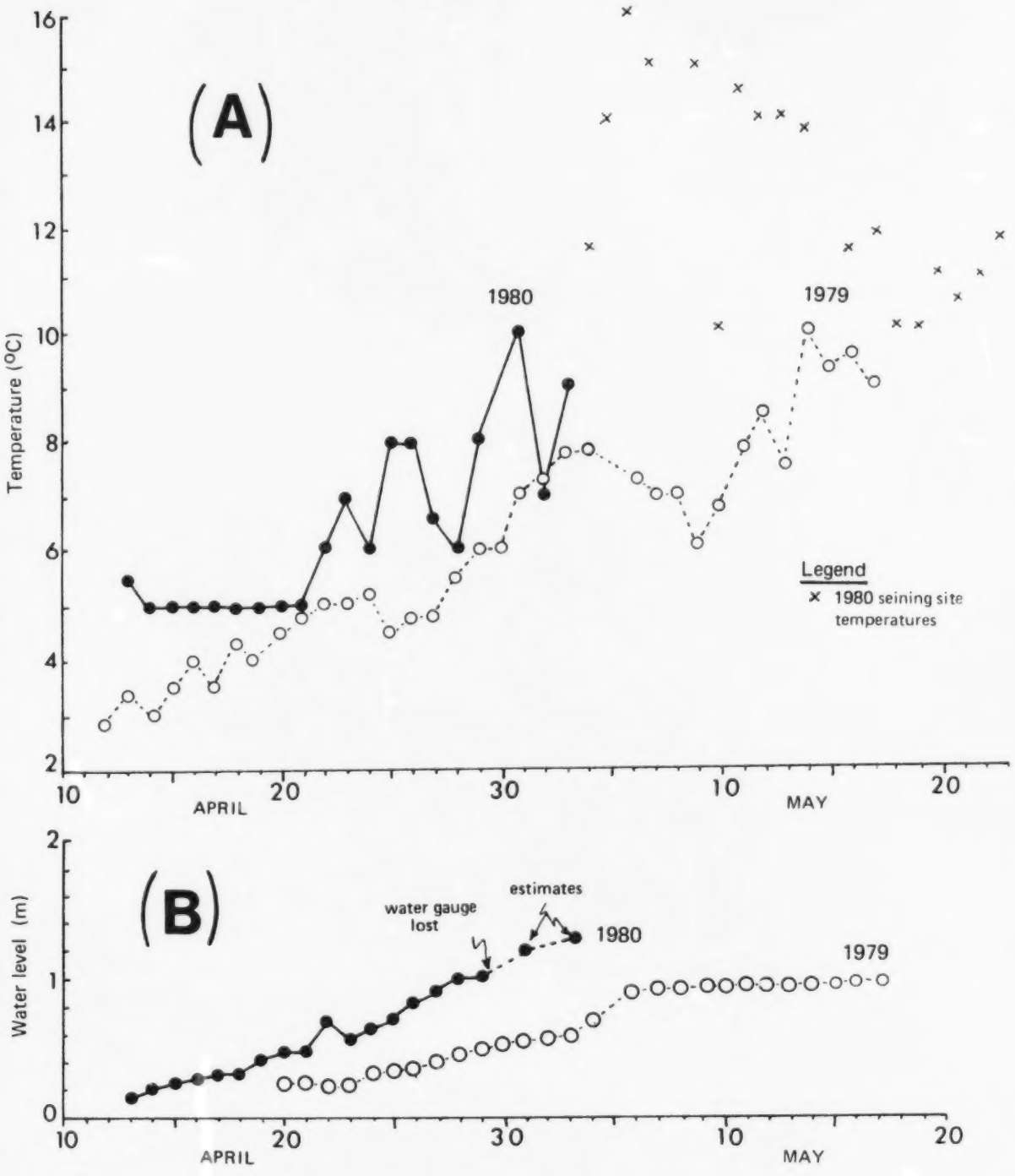

Fig. 11. Surface water temperatures at trapping and seining sites (A), and water levels (B), Lower Shuswap River, 1979, 1980.

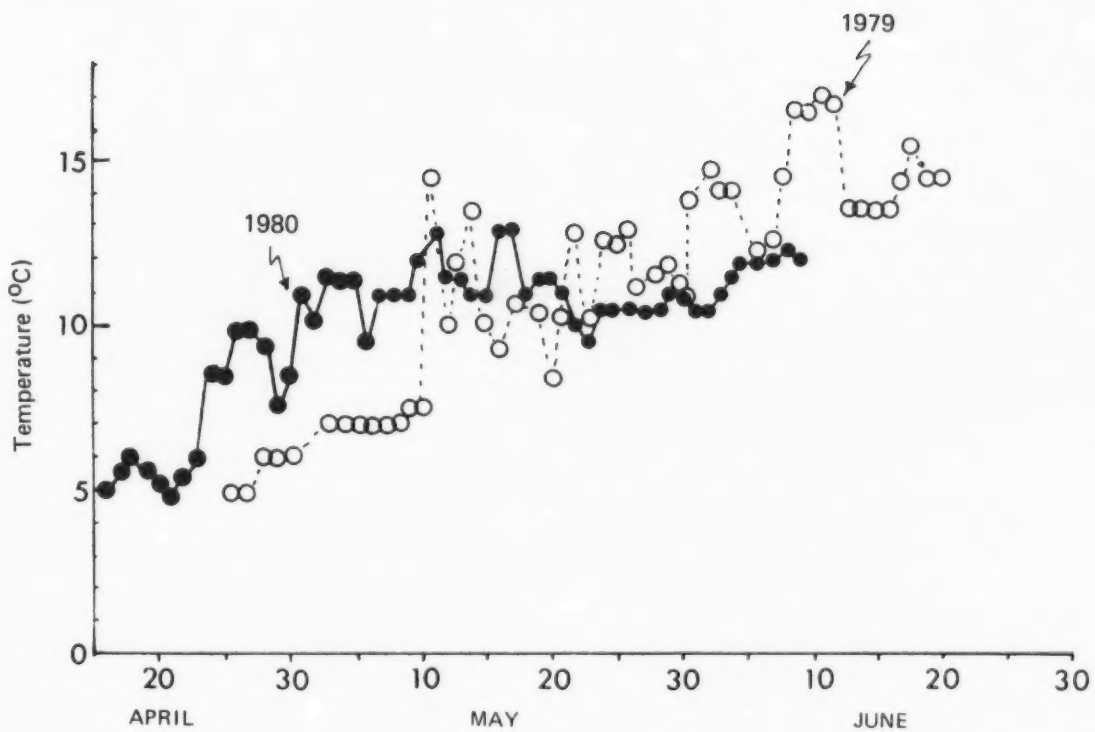

Fig. 12. Water temperatures at rearing pens, Mable Lake , April – June, 1979, 1980.

debris in the river, especially at the end of April, 1980.

Comparison of the above timing to peak emergence and distribution dates from other Fraser River chinook stocks indicate that the Shuswap River chinook are among the earlier emerging stocks in the Fraser River system: Upper Fraser River System, early to mid-May (Fedorenko and Fee 1983, Rosberg et.al. 1982); Chilko River, mid-May (Delaney et.al. 1982); North Thompson River, early to mid-May (Scott et.al. 1982); Nicola River, late April (DFO unpublished data).

Presmolting juveniles were present in the Shuswap and Little Shuswap lakes during summer. Graham and Russell (1979) also observed chinook juveniles in that area from April to July. These fish appear to migrate out of the Shuswap system throughout the summer, as indicated by declining beach seine catches with time. However, this decline in catch could also be a result of larger fish being better able to avoid capture by beach seines. Analysis of adult chinook scales sampled in 1975 and 1976 showed that 90% of the lower Shuswap River chinook and 60% of the middle Shuswap River chinook migrated to sea in their first year (0+); the remaining chinook migrated to sea in their second year after overwintering in the river or in the lakes of the Shuswap system during their first year.

REARING AREAS

Juvenile chinook rearing distribution is similar to adult spawning distribution in the lower Shuswap River, with flooded pastures, backwaters and sloughs adjacent to spawning areas being the preferred rearing habitats. Other important chinook rearing areas are the Shuswap and Little Shuswap lakes and the South Thompson River.

The productivity of beach seined lakes, based on the number of juveniles caught per seine set in 1976, was highest in Little Shuswap Lake where over 200 chinook were captured per set in late June. However, this capture success may not reflect the typical productivity of the area but, rather, the fact that chinook spawn in the Little River between Little Shuswap and Shuswap lakes, and this acts as a ready source of fry.

Capture success (catch/seine set) in Little Shuswap Lake declined rapidly in July, possibly the result of one or several factors such as removal by fishing with limited replenishment by new fry; an increased avoidance reaction by larger chinook to seining gear; rearing fry seeking deeper offshore waters to avoid higher surface temperatures; and the off-shore movement of rearing juveniles and their subsequent outmigration to sea. This seasonal decline in catch was also observed in Shuswap Lake during July and in the South Thompson River during August. Likewise, Graham and Russell (1979) found that most chinook juveniles from the Shuswap and Little Shuswap lake study area were unavailable to beach seines by the end of July. They observed an apparent temperature effect on chinook fry distribution since fry were scarce in foreshore areas where water temperatures exceeded 16°C. A possible offshore movement by fry to avoid high surface temperatures may have been observed in the 1976 study where July and August surface temperatures often exceeded 16°C at all capture sites. Captures per set were generally lowest in August at all sites, but were somewhat more productive at that time in the South Thompson River than in Little Shuswap Lake, suggesting the presence of downstream migrating chinook.

In 1979 and 1980 the relative productivity of areas in the lower Shuswap River could not be evaluated due to opportunistic and irregular seining at each site. Nevertheless, it was evident that sloughs and flooded pastures were important rearing areas for chinook.

NATURAL AND PEN REARED FRY SIZE

The size of chinook fry captured by beach seines in Little Shuswap Lake in 1976 increased from June to August (41 mm to 89 mm) indicating onsite rearing or recruitment of larger fish from other areas. The concurrent capture in July of smaller fry upstream in Mara Lake (57-61 mm on July 16 in Mara Lake compared to 65-75 mm in Little Shuswap Lake during the same period, Table 7, Append. 1), favours the explanation of local lake rearing. The relatively large chinook juveniles beach seined in August, 1976 in the South Thompson River may have been the downstream migrating lake reared fish. Among the South Thompson River fry, the smaller size of juveniles observed downstream at site 7, compared to the larger fish caught upstream at site 6, may be the result of smaller fish being displaced to downstream rearing areas.

Among the naturally rearing fry sampled in the spring of 1979 and 1980 mostly in the lower Shuswap River, those sampled in 1980 were generally larger and showed a greater seasonal growth than the naturally rearing fry captured in 1979. This size difference increased as the season progressed (Fig. 9, Tables 8 and 9). The apparent faster growth of naturally rearing fry in 1980 may be partly explained by higher water temperatures favouring fish growth, observed in the spring of that year (5-16^{o}C) compared to 1979 (3-10^{o}C) (Fig. 11), and by the difference in capture site and method. The smaller 1979 fry were captured in the cooler, mid-river waters and included largely those fish migrating to rearing areas. The larger 1980 fry probably included many locally rearing fish, since 40% of that year's catch was made in river backwaters generally considered to be good rearing habitats and having higher water temperatures than the mid-river waters (Fig. 11). Sizes of 1979 and 1980 naturally rearing chinook were not compared to the 1976 data due to difference in capture location and timing.

The apparent growth rates of the 1979 and 1980 pen rearing fry gave only an approximation of the actual growth rates because of the addition and redistribution of fish between enclosures. Thus, the apparent initial growth rate of pen rearing fry was depressed by successive additions of newly trapped, smaller fry.

Amounts of OMP used in 1979 and 1980 could not be related to overall fry growth because of considerable food wastage. In particular, the actual 1980 fry numbers in pens 1, 2 and 3 were less than 50% of the estimated numbers initially caught, largely due to fry escaping through damaged nets.

Fry sizes at release and apparent growth rates were similar in 1979 and 1980. However, compared to 1979, the 1980 Shuswap River pen rearing fry were generally larger during the rearing period (Fig. 9) partly due to an earlier start of rearing in 1980 and higher April to May water temperatures that year (Fig. 12).

Among the 1980 pen rearing fry, those captured by IPT (pens 3 and 4), were consistently larger than those captured by beach seines and stressed by sampling (pens 1 and 2) (Append. 15). This difference was expected since fry captured by IPT were pen reared for a longer period of time and appeared to adapt faster to the OMP diet compared to beach seined fry. Other variables, such as fry capture site, fry density per pen, and the large, possibly size selective escapement of fry from damaged pens in 1980, makes comparison of fish sizes among rearing enclosures and between years dubious.

In both 1979 and 1980, pen rearing Shuswap River fry were larger than the naturally rearing fry (Fig. 9). Naturally rearing fry captured at "Turtle Pond" and in Mara Lake on July 4 and 5, 1979 were smaller than the pen reared fry released in June of that year (Table 8). This difference in size may be attributed to the poor rearing

conditions in the wild, including less food and lower water temperatures compared to the pen rearing site. Also, a continuing down river migration of smaller fry may have further depressed the apparent growth rate of naturally rearing fry, as would the avoidance of nets by larger rearing fish. Limited and inconsistent sampling in the field precludes a quantitative analysis of naturally rearing and pen rearing fry growth rates.

FRY MORTALITY

The estimated pre- and post-tagging mortality of over 15,000 chinook during the 1976 program, may be an over estimate since most fish were released soon after tagging and may have suffered less stress than the samples held overnight. Tagging observations indicated that the hardiest fry with greatest post-tagging vigour were apparently downstream migrating, larger fry captured in August in the South Thompson River; the weakest fry were the smaller, lake rearing fish.

Fry mortality observed in 1976 was presumed to be the result of a combination of factors, although the relative importance of each could not be established. Causes of mortality did not appear to be related directly to location of capture site, fry transport technique, fry size or holding density in pens.

Stress from high water temperatures was a suspected cause of fry mortality in 1976. Surface water temperatures generally increased during the 1976 capture period and the highest fry mortality was observed in July in Shuswap Lake where temperatures were also the highest (up to 20°C). Shuswap Lake generally had higher near surface temperatures (16-20°C, July 5-31) than Little Shuswap Lake (13.5-17°C, July 5-31) (Append. 16a). Shuswap Lake also had a greater vertical temperature drop suggesting a possible depth refuge from the high near surface temperatures (Shuswap Lake, Station 5 : 18.5°C at 0 m, 12°C at 8 m vs. Little Shuswap Lake, Stations 1 and 3 : 15°C from 0-8 m) (Append. 16b). The reduced beach seine catches in 1976 possibly resulted from an apparent displacement of fry from foreshore areas due to high surface water temperatures. A possible temperature related displacement was also observed by Graham and Russell (1979). Because of the probable temperature related mortality, fry seining in Shuswap Lake was terminated after July 31.

Other causes of mortality in addition to temperature were suspected since chinook have a generally high temperature tolerance (Brett, 1952), and the surface water temperatures at 1976 tagging sites did not exceed 18°C throughout the program (Append. 17). Moreover, fry mortality was also high during the early, cooler part of the tagging season when surface water temperatures ranged between 12.0°C and 14.5°C (June 21 - July 7) (Append. 17). Therefore, in addition to the stress from high water temperatures, a further severe stress was probably experienced by fry from excessive fish handling and scale loss occurring during seining, sorting, transporting, holding and tagging.

In 1979 and 1980, the newly emergent fry were captured early in the spring, then reared in pens for over a month prior to tagging. By using this technique, the high temperatures encountered during the 1976 summer program (10-20°C in 1976 vs 3-15°C in 1979 and 5-16°C in 1980) were avoided. Also, while the 1976 fry experienced a consecutive and cumulative series of stresses (beach seining followed by immediate tagging), the 1979 and 1980 fry could recover from the capture shock during the extended rearing period before tagging began. Using the above rearing technique, Delaney et.al. (1982) and Hilland (1979) reported greater than 95% immediate post-tagging survival of chinook fry from the Chilcotin and Atnarko systems, respectively.

The holding mortality experienced in 1980 by the beach seined fry prior to transport to the rearing site, may be due largely to stress from handling. Fry were held in pails for up to eight hours at seining sites. Similarly, the higher pen rearing mortality in 1980 (3,900 fry) compared to 1979 (1,400 fry) may be related to the handling of fry caught by beach seine. As well, temperatures at the capture sites in some cases ranged from 9°C to 16°C and were higher than those at the rearing site by up to 2°C in the morning and 5°C in the afternoon. Temperature changes during transport may also have increased stress and contributed to mortality.

SUMMARY

1) During 1976, 1979 and 1980, juvenile chinook in the Shuswap and South Thompson River systems were captured and coded wire nose tagged.

2) Between June 28 and August 30, 1976, an estimated 51,000 juvenile chinook were captured by beach seine from Shuswap Lake, Little Shuswap Lake and South Thompson River; of these an estimated 13,200 fry were undersized (<55m) and were released.

3) During April to May, 1979 and 1980, an estimated 170,692 and 66,153 chinook fry, respectively, were captured from Lower Shuswap River below Mabel Lake by inclined plane traps. An estimated additional 47,983 fry were captured in May, 1980 from Lower Shuswap River using beach seines.

4) Peak fry migration in Lower Shuswap River occurred from late April to early May in 1979, and during mid-April in 1980. The capture of larger, smolting chinook in August, 1976 in the South Thompson River suggested a continuous summer outmigration of rearing juveniles.

5) During 1979 and 1980, captured chinook fry were reared from April to June in Mable Lake until they reached a mean tagging size of 60 mm.

6) In 1979, pen reared fry increased in size from 38.1 mm to 60.8 mm and from 0.48 g to 2.74 g. Their daily growth rate was 0.93% by length and 3.48% by weight. Pen rearing mortality was 1,932 fry.

7) In 1980, pen reared fry increased in size from 38.3 mm to 60.2 mm and from 0.46 g to 2.46 g. Their daily growth rate was 0.90% by length and 3.35% by weight. Pen rearing mortality was 3,876 fry.

8) In 1976 (June to August), naturally rearing chinook fry had a mean size range of 41.4 mm to 104.6 mm.

9) In 1979 (April to May), naturally rearing chinook fry measured 37.6 mm to 38.8 mm, and 0.41 g to 0.59 g.

10) In 1980 (April to June), naturally rearing chinook fry measured 38.1 mm to 57.1 mm, and 0.50 g to 2.29 g.

11) During late June to August 1976, 35,375 chinook fry were tagged with code 2-15-6. Of these, an estimated 19,034 fry were released with tags and adipose clips (corrected for overnight tag rejection and mortality). A combination of stresses related to high water temperatures, fish handling and scale loss, resulted in pre-tagged mortality of 3,828 fish and estimated post-tagging mortality of 15,578 fish. Size of released tagged fry ranged from 55 mm to 105 mm and all fish were age 0+.

12) In June 1979, 142,745 chinook fry were tagged and an estimated 141,502 were released with valid tags (corrected for overnight tag rejection). Two tag codes were used: code 2-16-25 for 122,797 fry and code 2-16-38 for 18,705 fry.

13) In June 1980, 60,394 chinook fry were tagged and an estimated 57,842 were released with valid tags (corrected for overnight tag rejection and mortality. Two tag codes were used: code 2-16-1 for 45,440 fry and code 2-17-55 for 12,402 fry.

14) In 1976, water temperatures at seining and tagging sites ranged from 10°C to 20°C.

15) In 1979, water temperatures at capture sites ranged from 3°C to 10°C and at rearing site from 5°C to 15°C.

16) In 1980, water temperatures at capture sites ranged from 5°C to 16°C and at rearing site from 5°C to 12°C.

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APPENDICES

Appendix 1. Mara Lake sampling, 1976

Exploratory trips to Mara Lake (Fig. 1) were made on July 16 and August 12, 1976. On July 16, 226 chinook fry were captured in five beach seine sets made along the southeastern 8 km of the shoreline. Mean fry lengths for three of the sets were 59.6 mm, 57.3 mm and 61.3 mm. Surface water temperature at seining sites ranged from 17-19°C. In addition, Gee minnow traps baited with roe, sausage and cheese were set in the Lower Shuswap River, from Mara Lake to Enderby (Fig. 1). Only two sculpins and one squawfish were captured, although chinook and coho fry were observed in the area.

On August 12, six chinook juveniles, ranging in size from 60-75 mm, were captured in Mara Lake in eight beach seine sets. Surface water temperature ranged from 21°C to 23°C. On both trips, large numbers of coarse fish were encountered, among them suckers, red side shiners, squawfish, juvenile carp, chub and whitefish.

Appendix 2. Location of beach seining sites, lower Shuswap River, 1980

Site No.	Location (Fig. 3)
1.	- 1 km below Maier's Landing, north bank; flooded meadow.
2.	- 0.4 km upstream of Trinity Bridge, north bank; flooded meadow.
3.	- 0.4 km upstream of Trinity Bridge, north bank; arm of a large side channel or backwater.
4.	- 0.4 km upstream of a sheep farm, north bank; small side channel.
5.	- at mouth of Trinity Creek under power lines, south bank; flooded pasture.
6.	- 0.8 km upstream of a sheep farm, north bank; shallow flooded meadow.
7.	- 0.2 km downstream of "Drop off" zone, south bank; flooded grassy backwater and pasture.
8.	- in front of a sheep farmhouse with red/white silo, north bank; mouth of a large backwater at edge of main current; pasture land.
9.	- 0.4 km downstream of power lines, north bank; backwater with sandy beach on edge of main current.
10.	- just upstream of site 9, off long grassy island; north bank.
11.	- under power lines, north bank; small flooded back channel.
12.	- ~2 km upstream of power lines, at Rooney's Farm, south bank; large side channel.
13.	- across from site 8, south bank; backwater.
14.	- downstream of site 8, below sheep farm; north bank; side channel.

Appendix 3. Oregon Pellet Feeding chart (R.V. Moore Co. Inc.) used in the Shuswap chinook rearing program, 1979, 1980.

Feeding level (L)* expressed as ratio of daily ration divided by fry total weight. Feeding frequency (F) expressed as number of days to feed per week and number of feedings per day. Example: 7/4 means feed 7 days per week, 4 times per day; E/1 means feed every other day, one feeding per day.

Ave. H^2O Temp. (F)	FISH SIZE (Number Per Pound) 800-300 L	F	300-200 L	F	200-135 L	F	135-90 L	F	90-60 L	F	60-40 L	F
35	2.7	7/5	2.3	7/4	1.8	7/2	1.6	6/1	1.3	5/1	1.4	E/1
6	2.8	7/5	2.4	7/4	1.9	7/2	1.8	6/1	1.4	5/1	1.4	E/1
7	2.9	7/5	2.5	7/4	2.0	7/2	1.9	6/1	1.5	5/1	1.6	E/1
8	3.0	7/5	2.6	7/4	2.1	7/2	2.0	6/1	1.7	5/1	1.8	E/1
9	3.2	7/5	2.7	7/4	2.2	7/2	2/1	6/1	1.8	5/1	1.8	E/1
40	3.4	7/5	2.8	7/4	2.3	7/2	1.9	7/1	1.6	6/1	1.3	5/1
1	3.6	7/5	2.9	7/4	2.4	7/2	2.0	7/1	1.8	6/1	1.3	5/1
2	3.8	7/5	3.0	7/4	2.5	7/2	2.1	7/1	1.9	6/1	1.4	5/1
3	4.0	7/5	3.1	7/4	2.6	7/2	2.2	7/1	2.0	6/1	1.5	5/1
4	4.2	7/5	3.3	7/4	2.7	7/2	2.3	7/1	2.1	6/1	1.7	5/1
45	4.4	7/5	3.5	7/4	2.8	7/2	2.4	7/1	2.2	6/1	1.8	5/1
6	4.6	7/5	3.7	7/4	2.9	7/2	2.5	7/1	2.3	6/1	2.0	5/1
7	4.8	7/5	3.9	7/4	3.0	7/2	2.6	7/1	2.5	6/1	2.1	5/1
8	5.0	7/5	4.1	7/4	3.2	7/2	2.7	7/1	2.6	6/1	2.2	5/1
9	5.3	7/5	4.3	7/4	3.4	7/2	2.8	7/1	2.7	6/1	2.4	5/1
50	5.6	7/5	4.5	7/4	3.6	7/2	2.9	7/1	2.8	6/1	2.1	6/1
1	5.9	7/5	4.7	7/4	3.8	7/2	3.0	7/1	2.9	6/1	2.2	6/1
2	6.2	7/5	4.9	7/4	4.9	7/2	3.2	7/1	3.0	6/1	2.3	6/1
3	6/5	7/5	5.1	7/4	4.2	7/2	3.4	7/1	3.2	6/1	2.5	6/1
4	6.8	7/5	5/4	7/4	4.4	7/2	3.6	7/1	3.3	6/1	2.6	6/1
55	7/1	7/5	5.7	7/4	4.6	7/2	3.8	7/1	3.5	6/1	2.7	6/1
6	7.5	7/5	6.0	7/4	4.8	7/2	4.0	7/1	3.7	6/1	2.8	6/1
7	7.9	7/5	6.3	7/4	5.0	7/2	4.2	7/1	4.0	6/1	2.9	6/1
8	8.3	7/5	6.6	7/4	5.3	7/2	4.4	7/1	4.2	6/1	3.0	6/1
9	8.7	7/5	6.9	7/4	5.6	7/2	4.6	7/1	4.4	6/1	3.2	6/1
60	9.1	7/5	7.2	7/4	5.9	7/2	4.8	7/1	4.7	6/1	3.3	6/1

RECOMMENDED PELLET SIZE

Fish Size (Number Per Pound)	Pellet Size (Inches)
800 - 500	1/32
500 - 250	3/64
250 - 150	1/16
150 - 50	3/32

Appendix 4a. Estimated daily catch of juvenile chinook by beach seine, number of sets, and catch per unit effort, Little Shuswap Lake seining sites (S), 1976.

Date	S-3		S-5		S-4		Total[b] catch	Total sets	Catch per set
	No. retained	No. released[a]	No. retained	No. released[a]	No. retained	No. released[a]			
06/28	-	-	405	1,625	-	-	2,030	9	226
06/29	-[c]	-	530	2,745	-	-	3,275	15	218
06/30	-	-	640	2,691	-	-	3,331	16	208
7/01	-	-	442	1,347	-	-	1,790	14	128
07/02	-	-	600	1,879	-	-	2,479	13	191
07/03	69	311	90	1,097	-	-	1,577	23	69
07/04	-	-	690	0	-	-	690[b]	20	35
07/05	155	0	610	20	-	-	785	13	60
07/06	1,006	181	-	-	-	-	1,187	12	99
07/07	100	50	364	298	-	-	812	13	62
07/12	1,315	0	162	0	-	-	1,469	51	29
07/13	550	2	405	5	-	-	962[b]	33	29
07/14	73	0	396	1	-	-	470	30	16
07/15	370	0	87	0	1,150	0	1,643	33	50
07/16	149	0	399	0	-	-	548[b]	19	29
07/17	373	0	629	0	12	0	1,019	40	25
07/18	720	0	967	0	169	0	1,866[b]	64	29
07/19	279	d	1,396	d	50	d	1,860[b]	52	36
07/20	661	0	388	0	83	0	1,132[d]	43	26
07/21	448	0	200	0	220	0	868	36	24
07/26	818	0	305	0	-	-	1,123	43	26
07/27	807	100	196	0	-	-	1,188	55	22
07/28	696	0	105	0	-	-	801[b]	64	13
07/29	1,006	0	268	0	168	0	1,342	78	17
07/30	352	0	318	0	104	0	772[b]	66	12
07/31	178	18	-	-	71	0	262[b]	35	7
08/01	18	0	864	0	41	0	924[b]	66	14
08/02	166	0	502	0	30	0	698[b]	59	12
08/03	202	0	192	0	8	0	442	54	8
08/04	209	0	414	0	6	0	680[b]	43	16
08/09	46	0	192	0	235	0	473[b]	29	16
08/10	36	0	9	0	217	0	312	21	15
08/11	-	-	48	0	218	0	293[b]	35	8
08/12	-	-	-	-	194	0	196[b]	11	18
08/13	170	0	51	0	109	0	330[b]	28	12
08/15	269	0	-	-	55	0	324	21	15
08/23	160	0	-	-	21	0	188	6	31
08/24	14	0	-	-	5	0	25[b]	6	4
08/28	21	0	61	0	-	-	76[b]	13	6
08/29	-	-	50	0	-	-	50[b]	e	e
08/30	-	-	-	-	-	-	0	1	0
Total	11,436	662	12,975	11,708	3,166	e	40,292[b]	1,283	-

[a] Mostly undersized fry <55 mm.
[b] Some discrepancy with sum of columns due to incomplete "No. released" data.
[c] Not seined.
[d] A total of 60 undersized fry released that day from total Little Shuswap Lake catch.
[e] Not available.

Appendix 4b. Estimated daily catch of juvenile chinook by beach seine, number of sets, and catch per unit effort, Shuswap and Mara Lake seining sites (S), 1976.

Date	Shuswap Lake (S-1 & 2)				Mara Lake			
	No. retained	No. released[a]	No. sets	Catch per set	No. retained	No. released	No. sets	Catch per set
Jul. 4	435	0	11	40	-[b]	-	0	-
Jul. 5	238	557	12	66	-	-	0	-
Jul. 6	170	171	14	24	-	-	0	-
Jul. 14	216	2	13	17	-	-	0	-
Jul. 15	204	0	14	15	-	-	0	-
Jul. 16	-	-	0	-	0	226	5	45
Jul. 17	57	0	8	7	-	-	0	-
Jul. 31	362	0	29	12	-	-	0	-
Aug. 12	-	-	0		6	0	8	1
Total	1,682	730	101	-	6	226	13	-

[a] Fry less than 55 mm.

[b] Not seined.

Appendix 4c. Estimated daily catch of juvenile chinook by beach seine, number of sets, and catch per unit effort, South Thompson River seining sites (S), 1976.

Date	S-6				S-7			
	No. retained	No. released[a]	No. sets	Catch per set	No. retained	No. released[a]	No. sets	Catch per set
08/10	335	0	12	28	-[b]	-	0	-
08/11	389	0	15	26	-	-	0	-
08/12	742	0	23	32	-	-	0	-
08/13	478	0	14	34	-	-	0	-
08/1	781	45	27	31	-	-	0	-
08/15	1,271	30	30	43	-	-	0	-
08/16	996	4	24	42	-	-	0	-
08/17	-	-	0	-	375	0	17	22
08/18	229	0	13	18	369	4	21	18
08/23	-	-	0	-	385	2	25	15
08/24	-	-	0	-	72[c]	1	9	8
08/25	-	-	0	-	443	5	38	12
08/26	23	0	4	6	449	2	47	10
08/27	268	2	23	12	110	2	26	4
08/28	342	4	36	10	-	-	0	-
08/29	115	1	28	4	-	-	0	-
08/30	88	0	13	7	-	-	0	-
Total	6,057	86	262	-	2,203	16	181	-

[a] Fry less than 55 mm.

[b] Not seined.

[c] Includes some juveniles from S-6.

Appendix 5. Number of chinook fry caught per trap, lower Shuswap River, 1979.

Date	4X4 trap		2X3 trap(#1)		2X3 trap(#2)		2X3 trap(IPSFC)		Daily total	
	No. live	No. dead	No. live	No. dead	No. live	No. dead	No. live	No. dead	No. live	No. dead
04/12	(included with April 13)		-[a]	-[a]	-	-	-	-	-	-
04/13	468	13	-	-	84	1	-	-	552	14
04/14	499	4	-	-	124	1	-	-	623	5
04/15	382	4	-	-	203	11	-	-	585	15
04/16	817	5	-	-	43	1	-	-	860	6
04/17	1,841	18	629	2	793	9	-	-	3,263	29
04/18	1,150	21	395	8	637	16	-	-	2,182	45
04/19	964	69	302	1	232	3	-	-	1,498	73
04/20	768	148	418	8	444	6	-	-	1,630	154
04/21	1,105	13	386	3	128	10	-	-	1,619	26
04/22	1,263	23	442	7	371	4	-	-	2,076	34
04/23	1,610	86	148	16	593	18	-	-	2,351	120
04/24	606	140	735	15	544	32	-	-	1,885	187
04/25	2,934	110	1,375	31	145	7	-	-	4,454	148
04/26	4,177	13	1,487	11	736	29	-	-	6,400	53
04/27	3,146	5	1,031	14	205[b]	0	-	-	4,382	19
04/28	14,020	59	5,256	23	6,456	34	-	-	25,732	116
04/29	4,629	3	2,131	24	2,274	44	-	-	9,034	71
04/30	5,820	78	2,163	5	4,776	14	-	-	12,759	97
05/01	6,808	23	4,221	11	1,804	12	1,632	3	14,465	49
05/02	4,623	2	1,956	2	2,931	5	2,938	2	12,448	11
05/03	3,956	26	1,449	2	1,513	1	660	0	7,578	29
05/04	3,694	24	1,752	3	1,788	23	1,589	0	8,823	50
05/05	-	-	-	-	-	-	-	-	-	-
05/06	1,318	299	330	5	370	1	565	0	2,583	305
05/07	356	136	694	5	343	3	417	6	1,810	150
05/08	1,985	8	638	6	431	3	307	1	3,361	18
05/09	1,193	12	592	3	515	1	223	2	2,523	18
05/10	919	26	504	8	630	2	724	2	2,777	38
15/11	1,678	8	480	4	620	3	797	3	3,575	18
05/12	1,240	11	483	12	798	6	1,072	3	3,593	32

Appendix 5. (continued).

Date	4X4 trap		2X3 trap(#1)		2X3 trap(#2)		2X3 trap(IPSFC)		Daily total	
	No. live	No. dead	No. live	No. dead	No. live	No. dead	No. live	No. dead	No. live	No. dead
05/13	1,608	17	389	5	532	3	835	2	3,364	27
05/14	2,526	50	1,014	7	1,056	18	969	4	5,565	79
05/15	2,637	24	1,499	42	1,589	8	995	0	6,720	74
05/16	2,631	27	1,533	3	1,592	11	904	0	6,660	41
05/17	1,138	17	512	4	825	4	487	0	2,962	25
Total	84,509	1,470	34,944	290	36,125	344	15,114	28	170,692	2,132

[a] No trapping.

[b] Trap moved to Trinity Bridge for one day.

Appendix 6. Number of chinook fry caught per trap, lower Shuswap River, 1980.

Date	4X4 trap(#1)		4X4 trap(#2)		2X3 trap(IPSFC)		Daily total	
	No. live	No. dead	No. live	No. dead	No. live	No. dead	No. live	No. dead
04/13	509	2	1,628	5	-[a]	-	2,137	7
04/14	2,131	2	3,122	10	-	-	5,253	12
04/15	1,858	0	2,525	17	-	-	4,383	17
04/16	1,825	2	2,164	1	-	-	3,989	3
04/17	1,608	5	1,701	8	-	-	3,309	13
04/18	1,349	1	2,001	2	925	2	4,275	5
04/19	10,695	46	7,237	25	217	0	18,149	71
04/20	793	0	977	29	80	0	1,850	29
04/21	943	19	1,642	22	124	1	2,709	42
04/22	773	15	1,148	68	526	0	2,447	83
04/23	4,158	23	3,555	95	270	1	7,983	119
04/24	358	63	838	96	244	0	1,440	159
04/25	1,347	227	1,313	283	370	0	3,030	510
04/27	643	11	420	7	17	0	1,000	10
04/28	118	8	467[b]	13	2	0	587	21
04/29	240	4	249	8	1	0	490	12
04/30	-	-	0	150	-	-	0	150
05/01	72	7	-	-	-	-	72	7
05/02	265	11	-	-	-	-	265	11
05/03	199	17	55	3	-	-	254	20
Total	31,092	500	32,142[b]	849	2,919	4	66,153	1,353

[a] No trapping.

[b] Includes 26 fry lost at trap.

Appendix 7. Chinook fry catches and water temperature data, lower Shuswap River, 1980.

Date	Seining site (Fig. 3)	Water surface temperature (°C)	No. live	No. dead
05/04[a]	1	11.5	1,536	1
05/05[b]	1	14.0	3,158	44
05/06	1-4	16.0	6,339	29
05/07	1	15.0	3,405	248
05/08	1	-	583	0
05/09	1	15.0	3,157	30
05/10	5	10.0	4,111	308
05/11	1	14.5	1,343	6
05/12	6	14.0	2,446	32
05/13	1	14.0	836	0
05/14	6	13.5	1,379	0
05/16	6	11.5	1,372	0
05/17[c]	9,10,11,12	11.0-13.0	3,705	0
05/18	6,8	9.0-11.0	3,414	0
05/19	6,7,8,9,13	10.0	2,655	0
05/20	9	11.0	1,540	0
05/21	9,12,14	10.0-11.0	4,090	2
05/22	8,12,13	11.0	2,095	0
05/23	12	12.0	819	4
Total	-	-	47,933	704

[a] Beach seine and dip net.

[b] Beach seine and pole seine

[c] May 17-23, fry estimates made (not counts).

Appendix 8a. Daily beach seine catch of fish other than chinook juveniles, and number of sets per day, Little Shuswap Lake, 1976.[a]

Date	No. sets	Fish species										
		Coho fry	Coho smolts	Sockeye fry	Sockeye smolts	Carp	Rainbow trout	Red side shiner	Sculpin	Squaw	Sucker fish	White fish
07/01	14	-[b]	1	20	33	-	-	-	-	-	1	18
07/02	13	-	2	-	11	-	-	-	-	-	2	2
07/03	23	-	12	6	12	-	-	-	15	-	9	3
07/04	20	-	-	283	-	-	-	-	8	-	2	8
07/05	13	-	4	1	-	-	-	-	-	-	2	8
07/06	12	-	2	15	-	-	-	-	-	-	-	-
07/07	13	-	1	1061	-	-	1	-	1	-	4	-
07/12	51	-	1	503	-	-	-	-	-	-	-	3
07/13	33	-	-	200	3	-	1	1	55	1	6	3
07/14	30	-	-	2	9	-	-	-	-	1	5	3
07/15	33	-	-	1	-	-	-	-	8	-	4	1
07/16	19	-	-	-	-	-	-	-	18	-	4	19+
07/17	40	-	-	-	-	-	-	2	-	-	4	26
07/18	64	-	-	25	-	-	-	-	5	-	9	12
07/19	52	-	-	-	11	-	1	-	2	2	10	6
07/20	43	-	-	24	4	-	-	-	-	-	19	14
07/21	36	-	-	-	-	-	-	50	-	2	-	-
07/26	43	-	-	3	-	-	-	1	-	-	23	12
07/27	55	-	-	-	-	-	-	-	-	1	6	19
07/28	64	-	-	4	-	-	-	-	-	-	15	16
07/29	78	-	-	4	-	-	4	-	-	-	6	8
07/30	66	1	-	1	5	-	2	-	15	-	9	3
07/31	35	-	-	150	-	-	-	-	-	-	2	3
08/01	66	1	-	3	2	-	1	3	-	-	33	6
08/02	59	-	-	11	-	-	1	-	-	-	5	2
08/03	54	-	-	10	-	-	-	4	-	-	3	4
08/04	43	-	-	1	-	-	1	-	-	-	2	61
08/09	29	-	-	1	-	-	-1200	-	-	-	5	34

Appendix 8a. (Continued).

Date	No. sets	Fish species										
		Coho fry	Coho smolts	Sockeye fry	Sockeye smolts	Carp	Rainbow trout	Red sided shiner	Sculpin	Squaw	Sucker fish	White fish
08/10	21	-	-	-	-	-	-	-	-	1	1	-
08/11	35	-	-	-	-	-	-	-	-	1	5	10
08/12	11	-	-	1	-	-	-	2	-	-	-	1
08/13	28	-19[c]	-	-	-	-	-	-	-	1	3	4
08/15	21	-	-	1	-	-	-	-	-	-	-	3
08/23	6	-	-	-	-	-	-	-	-	-	-	-
08/24	6	-	-	2	1	-	-	6	-	-	-	28
08/28	13	-	-	1	-	-	-	2	-	-	13	8

[a] All seining sites combined.

[b] None observed.

[c] Developmental stage unknown.

Appendix 8b. Daily beach seine catch of fish other than chinook juveniles, and number of sets per day, Shuswap Lake, Mara Lake and South Thompson River[a], 1976.

Date	No. sets	Fish species										
		Coho fry	Coho smolts	Sockeye fry	Sockeye smolts	Carp	Rainbow trout	Red side shiner	Sculpin	Squaw	Sucker fish	White fish
Shuswap Lake												
07/05	12	-[b]	-	145	-	-	-	2	2	-	3	5
07/06	14	-	-	1800	-	-	-	14	27	-	-	2
07/14	13	-	-	1	-	-	-	1	7	-	-	1
07/15	14	-	-	-	-	-	-	-	-	3	1	2
Mara Lake												
07/16	5	-	-	-	-	-	-	-	-	2	-	4
08/12	8	-	-	-	-	-	-	24	-	1	-	1
South Thompson River												
08/10	12	-	-	-	-	-	-	-	-	-	-	3
08/11	15	-	-	-	-	-	-	15	-	-	-	4
08/12	23	-	-	1	-	-	-	-	-	-	-	31
08/13	14	-	-	-	-	-	-	-	-	1	-	-
08/14	27	-	-	230+	-	-	-	6	-	-	-	42
08/15	30	-	-	-	-	-	-	-	-	2	-	2
08/16	24	-	-	-	262	-	-	1	-	1	-	-
08/17	17	-	-	-	-	-	-	20	-	-	8	45
08/18	34	-	-	5	-	-	-	-	-	-	11	70
08/23	25	-	-	1	25	1	-	30	-	-	1	59
08/24	9	-	-	-	-	-	-	-	-	-	-	-
08/25	38	-	-	156	6	-	1	3	-	-	3	104
08/26	51	-	-	-	-	1	1	3	-	-	-	118
08/27	49	-	-	35	70	-	1	-	-	-	6	25

Appendix 8b. (Continued).

Date	No. sets	Fish species										
		Coho fry	Coho smolts	Sockeye fry	Sockeye smolts	Carp	Rainbow trout	Red side shiner	Sculpin	Squaw	Sucker fish	White fish
08/28	36	4	2	2	-	-	1	1	-	-	4	4
08/29	28	-	15	+	9	-	-	2	1	-	3	20
08/30	13	-	-	41	-	-	-	61	-	-	-	3

[a] S-6 and S-7 combined for South Thompson River.

[b] None observed.

Appendix 9. Age, estimated catch and size of salmonid juveniles other than chinook fry, lower Shuswap River, 1979, 1980 (n gives sample size).

Date	Species	Age	Catch (approx.)	Length ± (mm)	1 S.E.	Weight (g)	
1979							
12/4-17/5	Chinook smolts	1+	12	103.1±2.7	(n=12)	-	
12/4-17/5	Coho fry	0+	400[a]	-		-	
29/4- 9/5	Coho smolts	1+[b]	75	99.6±2.1	(n= 75)	-	
10/5-14/5	Coho smolts	1+[b]	98	102.3±1.1	(n= 98)	-	
12/4-17/5	Sockeye fry	0+	44,900[a]	29.8±0.1	(n=1--)[c]	0.21	(n=100)[c]
12/4-15/5	Sockeye smolts	-	18	-		-	
1980							
10/5	Chinook smolts	1+	1	-		-	
13/4-23/5	Coho fry	0+	107	-		-	
27/4-29/4	Coho smolts	1+[d]	15	81.6±2.8	(n+ 15)	-	
2/5- 9/5	Coho smolts	1+[d]	39	90.1±2.2	(n= 39)	-	
10/5-22/5	Coho smolts	1+[d]	87	100.3±1.0	(n= 87)	-	
13/4-23/5	Sockeye fry	0+	6,336[a]	-		-	
13/4-23/5	Sockeye smolts	-	5,017[a]	-		-	

[a] Approximate.

[b] 6% of total (n=71) scales read ⟶ were age 2+.

[c] May 11 catch.

[d] 4% of total (n=138) scales read ⟶ were age 2+.

APPENDIX 10. SHUSWAP TAGGING RESULTS 1976

DATE	NUMBER TAGGED	MORTALITY			NUMBER RELEASED	TAG REJECTION				ESTIMATED NUMBER RELEASED	
		NUMBER HELD	NUMBER DEAD	MORT-ALITY RATE		NUMBER QCD	NUMBER REJECTS	REJECT-ION RATE	RETENT-ION RATE	TAGGED	UNTAGGED
JUNE 20	68	68	46	0.68	22	46	3	0.07	0.93	21	1
21	191	191	68	0.36	123	105	20	0.19	0.81	100	23
23	128	128	32	0.25	96	0	0	0.04	0.96	92	4
30	1136	1136	239	0.21	897	377	19	0.05	0.95	852	45
JULY 1	398	398	36	0.09	362	0	0	0.04	0.96	348	14
2	27	27	4	0.15	23	0	0	0.04	0.96	22	1
2	364	364	109	0.30	255	0	0	0.04	0.96	245	10
3	148	148	65	0.44	83	81	1	0.01	0.99	82	1
4	131	131	20	0.15	111	96	19	0.20	0.80	89	22
4	286	286	38	0.13	248	0	0	0.04	0.96	239	9
5	326	326	97	0.30	229	100	2	0.02	0.98	224	5
5	360	360	41	0.11	319	117	17	0.15	0.85	273	46
5	268	268	163	0.61	105	102	2	0.02	0.98	103	2
6	306	306	30	0.10	276	96	7	0.07	0.93	256	20
6	393	393	80	0.20	313	106	3	0.03	0.97	304	9
6	174	174	110	0.63	64	51	3	0.06	0.94	60	4
7	946	946	49	0.05	897	253	13	0.05	0.95	851	46
7	722	722	120	0.17	602	0	0	0.04	0.96	579	23
13	690	690	140	0.20	550			0.11	0.89	489	61
13	497	497	93	0.19	404	388	43	0.11	0.89	359	45
13	656	656	347	0.53	309			0.11	0.89	275	34
14	115	115	42	0.37	73	70	0	0.00	1.00	73	0
14	381	381	200	0.52	181	115	0	0.00	1.00	181	0
15	283	283	137	0.48	146	89	0	0.00	1.00	146	0
15	58	58	0	0.00	58	58	0	0.00	1.00	58	0
15	176	176	67	0.38	109	72	2	0.03	0.97	106	3
15	1124	1124	631	0.56	493	58	0	0.00	1.00	493	0
16	198	198	6	0.03	192	63	0	0.00	1.00	192	0
16	438	438	131	0.30	307	67	0	0.00	1.00	307	0
17	155	155	61	0.39	94	0	0	0.04	0.96	90	4
17	68	68	54	0.79	14	0	0	0.04	0.96	13	1
17	957	957	445	0.46	512	50	0	0.00	1.00	512	0
18	284	50	14	0.28	204	37	0	0.00	1.00	204	0
18	688	50	12	0.24	523	38	1	0.03	0.97	509	14
18	364	50	20	0.40	218	30	0	0.00	1.00	218	0
19	490	50	10	0.20	392	0	0	0.04	0.96	377	15
19	207	50	32	0.64	75	18	0	0.00	1.00	75	0
19	289	50	30	0.60	116	20	2	0.10	0.90	104	12
19	928	50	35	0.70	278	16	0	0.00	1.00	278	0
20	336	50	12	0.24	255	38	0	0.00	1.00	255	0
20	193	50	13	0.26	143	25	0	0.00	1.00	143	0
20	85	0	0	0.54	39	0	0	0.04	0.96	38	1
20	91	50	28	0.56	40	22	1	0.05	0.95	38	2
20	465	50	16	0.32	316	34	1	0.03	0.97	307	9
21	684	50	16	0.32	465	0	0	0.04	0.96	448	17
21	627	50	40	0.80	125	0	0	0.04	0.96	121	5
21	537	0	0	0.54	247	0	0	0.04	0.96	238	9
27	607	40	19	0.48	319	21	0	0.00	1.00	319	0

(CONT...)

APPENDIX 10. SHUSWAP TAGGING RESULTS 1976 (CONT.)

DATE	NUMBER TAGGED	MORTALITY			NUMBER RELEASED	TAG REJECTION				ESTIMATED NUMBER RELEASED	
		NUMBER HELD	NUMBER DEAD	MORT-ALITY RATE		NUMBER QCD	NUMBER REJECTS	REJECT-ION RATE	RETENT-ION RATE	TAGGED	UNTAGGED
27	176	0	0	0.54	81	0	0	0.04	0.96	78	3
27	407	50	30	0.60	163	19	0	0.00	1.00	163	0
27	393	50	27	0.54	181	23	1	0.04	0.96	173	8
28	454	60	37	0.62	174	23	1	0.04	0.96	166	8
28	197	50	33	0.66	67	50	0	0.00	1.00	67	0
28	203	50	26	0.52	97	50	0	0.00	1.00	97	0
29	323	46	31	0.67	105	46	1	0.02	0.98	103	2
29	22	0	0	0.54	10	0	0	0.04	0.96	10	0
29	180	53	22	0.42	105	53	6	0.11	0.89	93	12
29	92	0	0	0.54	42	0	0	0.04	0.96	41	2
29	10	0	0	0.54	5	0	0	0.04	0.96	4	0
30	627	50	41	0.82	113	50	1	0.02	0.98	111	2
30	190	0	0	0.54	87	0	0	0.04	0.96	84	3
30	164	50	38	0.76	39	0	0	0.04	0.96	38	1
31	35	0	0	0.54	16	0	0	0.04	0.96	15	1
31	277	47	38	0.81	53	47	5	0.11	0.89	47	6
31	270	44	40	0.91	25	94	8	0.09	0.91	22	2
AUG 1	115	0	0	0.54	53	0	0	0.04	0.96	51	2
1	258	50	23	0.46	139	100	4	0.04	0.96	134	6
2	324	0	0	0.54	149	0	0	0.04	0.96	143	6
2	205	50	34	0.68	66	150	8	0.05	0.95	62	3
2	207	0	0	0.54	95	0	0	0.04	0.96	92	4
3	158	50	18	0.36	101	50	3	0.06	0.94	95	6
3	331	0	0	0.54	152	0	0	0.04	0.96	147	6
4	94	0	0	0.54	43	0	0	0.04	0.96	42	2
4	399	0	0	0.54	184	0	0	0.04	0.96	177	7
4	278	0	0	0.54	128	0	0	0.04	0.96	123	5
9	193	50	42	0.84	31	50	1	0.02	0.98	30	1
10	320	50	28	0.56	141	50	2	0.04	0.96	135	6
10	201	50	33	0.66	68	50	1	0.02	0.98	67	1
11	205	50	31	0.62	78	50	0	0.00	1.00	78	0
12	450	50	18	0.36	288	50	1	0.02	0.98	282	6
13	104	0	0	0.54	48	0	0	0.04	0.96	46	2
13	547	48	28	0.58	228	48	0	0.00	1.00	228	0
14	179	0	0	0.54	82	0	0	0.04	0.96	79	3
14	970	0	0	0.54	446	0	0	0.04	0.96	429	17
15	1452	48	5	0.10	1301	48	1	0.02	0.98	1274	27
16	1377	0	0	0.54	633	0	0	0.04	0.96	610	24
17	873	0	0	0.54	402	0	0	0.04	0.96	386	15
18	711	0	0	0.54	327	0	0	0.04	0.96	315	12
23	349	0	0	0.54	161	0	0	0.04	0.96	155	6
24	106	0	0	0.54	49	0	0	0.04	0.96	47	2
24	159	50	32	0.64	57	0	0	0.04	0.96	55	2
25	403	0	0	0.54	185	0	0	0.04	0.96	178	7
26	406	0	0	0.54	187	0	0	0.04	0.96	180	7
27	239	50	36	0.72	67	0	0	0.04	0.96	64	3
28	358	0	0	0.54	165	0	0	0.04	0.96	158	6
29	253	0	0	0.54	116	0	0	0.04	0.96	112	4
30	88	0	0	0.54	40	0	0	0.04	0.96	39	2
TOTAL	35375				19797					19034	763

APPENDIX 11. SHUSWAP TAGGING RESULTS 1979

DATE	TAG CODE	NUMBER TAGGED	NUMBER RELEASED	TAG REJECTION				ESTIMATED NUMBER RELEASED	
				NUMBER QCD	NUMBER REJ	REJECTION RATE	RETENTION RATE	TAGGED	UNTAGGED
JUNE 13	16-25	1808	1808	457	5	0.01	0.99	1788	20
14	16-25	11383	11383	500	18	0.04	0.96	10973	410
15	16-25	8185	8185	0	0	0.01	0.99	8131	54
16	16-25	12033	12033	366	6	0.02	0.98	11836	197
17	16-25	11514	11514	700	3	>0.00	<1.00	11465	49
18	16-25	15851	15851	700	7	0.01	0.99	15692	159
19	16-25	15622	15622	200	0	0.00	1.00	15622	0
20	16-25	12783	12783	1517	6	>0.00	<1.00	12732	51
21	16-25	13168	13168	500	0	0.00	1.00	13168	0
21	16-38	1589	1589	0	0	0.01	0.99	1578	11
22	16-38	8007	8007	520	3	0.01	0.99	7961	46
22	16-25	7291	7291	0	0	0.01	0.99	7243	48
23	16-38	6064	6064	0	0	0.01	0.99	6024	40
23	16-25	7259	7259	0	0	0.01	0.99	7211	48
24	16-25	7025	7025	1025	13	0.01	0.99	6936	89
24	16-38	3163	3163	0	0	0.01	0.99	3142	21
TOTAL	16-25	123922	123922					122797	1125
	16-38	18823	18823					18705	118
TOTAL		142745	142745					141502	1243

APPENDIX 12 SHUSWAP TAGGING RESULTS 1980

DATE	TAG CODE	NUMBER TAGGED	MORTALITY			NUMBER RELEASED	TAG REJECTION				ESTIMATED NUMBER RELEASED	
			NUMBER HELD	NUMBER DEAD	MORTALITY RATE		NUMBER QCD	NUMBER REJ	REJECTION RATE	RETENTION RATE	TAGGED	UNTAGGED
JUNE 4	16-1	1755	1755	8	.0045584	1747	214	3	0.01	0.99	1723	24
4	16-1	1548	1548	0	0	1548	204	6	0.03	0.97	1502	46
5	16-1	5773	2800	3	.0010714	5767	0	-	0.03	0.97	5622	145
5	16-1	5589	2600	0	0	5589	217	3	0.01	0.99	5512	77
6	16-1	4079	1866	2	.0010718	4075	204	16	0.08	0.92	3755	320
6	16-1	5888	5888	45	.0076427	5843	426	9	0.02	0.98	5720	123
7	16-1	5160	2478	27	.0108959	5104	200	6	0.03	0.97	4951	153
7	16-1	5009	2642	390	.1476154	4270	200	1	0.01	1.00	4248	21
8	16-1	4964	4964	11	.0022160	4953	200	1	0.01	1.00	4928	25
9	16-1	7856	7456	105	.0140826	7745	204	7	0.03	0.97	7480	266
10	17-55	7011	7011	50	.0071317	6961	200	4	0.02	0.98	6822	139
10	17-55	5762	2625	17	.0064762	5725	159	4	0.03	0.97	5581	144
TOTAL	16-1	47621				46640					45440	1200
	17-55	12773				12686					12402	283
TOTAL		60394				59326					57842	1483

Appendix 13. Juvenile tag recovery data.

Date	Sample[a] Location	Surface Water Temp.	No. Seine Sets	Untagged Chinook No. Caught	Untagged Chinook Mean Length ± SE(n)	Tagged Chinook No. Caught	Tagged Chinook Mean Length ± SE(n)
1979							
Jul. 4	Turtle Pond	17.5	2	89	53.8±1.0(69)	3	59.7±2.3(3)
Jul. 5	Mara Lake[c]	19.0	2	72	52.8±0.7(63)	1	60.0 (1)
1980							
Jun. 11	S-12	16.0	2	104	51.1±0.7(50)	0	-
18	S-12	17.5	1	31	57.1±0.8(50)	0	-
18	Mable Lake outlet	15.0	2	70	54.2±1.0(50)	0	-
18	Turtle Pond	16.5	1	126	53.6±1.0(31)	2	54.5±1.5(2)
18	S-9	19.5	1	93	53.9±0.8(50)	0	-
19	Mara Lake	16.0	3	610	53.2±0.7(50)	1	53.0 (1)
19	Mable Lake outlet	16.5	1	87	60.7±0.8(50)	3	66.0±1.7(3)
Jul. 24	Mara Lake	22.5	2	1	-	0	-
24	Turtle Pond	22.5	1	7	73.0±2.5(7)	0	-
25	S-6[d]	18.5	7	42	77.9±1.0(42)	0	-

[a] See Fig. 3.

[b] Upstream of rearing site.

[c] Off Provincial Park Beach (Fig. 1).

[d] South Thompson River (Fig. 2).

Appendix 14. Mean nose-fork length (L; n=100) and weight (W; n=100 in aggregate) of rearing chinook fry in each enclosure, Mabel Lake, April to June, 1979.

Date	Pen 1		Pen 2		Pen 3		Pen 4		Raceway	
	L ± S.E. (mm)	W (g)	L ± S.E. (mm)	W (g)	L ± S.E. (mm)	W (g)	L ± S.E. (mm)	W (g)	L ± S.E. (mm)	W (g)
04/26	38.1±0.14	0.48	-	-	-	-	-	-	-	-
05/05	39.5±0.18	0.47	-	-	-	-	-	-	-	-
05/11	40.0±0.18	0.67	39.0±0.21	0.56	-	-	39.0±0.21		0.59	-
05/18	42.3±0.34	0.83	39.4±0.32	0.50	-	-	40.3±0.25		0.67	-
05/25	45.4±0.48	1.19	43.1±0.47	0.96	43.3±0.46		1.00	45.2±0.36		1.17
06/01	50.6±0.59	1.59	49.0±0.58	1.41	45.4±0.67		1.13	49.9±0.52		1.55
06/08	58.8±0.63	2.29	49.9±0.54	2.07	57.4±0.69		2.15	59.0±0.61		2.31
06/15	62.6±0.67	2.76	59.4±0.85	2.56	62.3±0.65		3.05	61.6±0.81		2.93

Appendix 15. Mean nose-fork length (L; n=50) and weight (W; n=100 in aggregate) and condition factor (K) of rearing chinook fry in each pen, Mabel Lake, April to June, 1980.

Date	Pen 1			Pen 2			Pen 3			Pen 4		
	L ± S.E. (mm)	W (g)	K	L ± S.E. (mm)	W (g)	K	L ± S.E. (mm)	W (g)	K	L ± S.E. (mm)	W (g)	K
04/21	-	-	-	-	-	-	38.2±0.19	0.46	0.83	38.3±0.19	0.47	0.84
04/28	-	-	-	-	-	-	38.3±0.19	0.44	0.78	39.1±0.24	0.47	0.79
05/05	-	-	-	-	-	-	39.7±0.30	0.60	0.96	41.0±0.30	0.67	0.97
05/12	41.3±0.37	0.73	1.04	39.0±0.32	0.53	0.89	43.7±0.41	0.91	1.09	43.4±0.46	0.83	1.02
05/19	45.2±0.61	0.92	1.00	42.6±0.40	0.72	0.93	46.8±0.43	1.16	1.13	48.8±0.57	1.29	1.11
05/26	49.9±0.63	1.22	0.98	47.1±0.58	1.05	1.00	54.7±0.47	1.68	1.07	56.1±0.53	1.97	1.12
05/29	-	-	-	-	-	-	55.3±0.59	1.87	1.11	58.0±0.61	2.31	1.18
06/02	55.7±0.76	2.08	1.20	52.6±0.63	1.68	1.15	59.1±0.57	2.38	1.15	62.9±0.45	2.87	1.15
06/06	-	-	-	-	-	-	-	-	-	61.0±0.78	2.27	1.00
06/09	58.8±0.81	2.21	1.09	60.3±0.76	2.78	1.27	61.4±0.82	2.39	1.03	-	-	-

Appendix 16a. Surface water temperatures (°C) at Shuswap and Little Shuswap Lake seining sites (S), 1976.

Date	Shuswap Lake	Little Shuswap Lake			
	S-1	S-3	S-4	S-5	Other
06/28	-	-[a]	-	-	10.0
06/29	-	-	-	-	11.0
06/30	-	-	-	-	12.0
07/01	-	-	11.0	-	-
07/02	-	-	12.0	-	-
07/03	-	12.0	-	12.0	-
07/04	-	-	-	12.5	-
07/05	16.0	-	-	-	13.0
07/06	18.0	-	-	-	-
07/07	-	14.0	-	-	-
07/12	-	14.5	-	13.5	-
07/13	-	15.5	-	15.0	-
07/14	19.0	15.5	-	17.0	-
07/15	19.0	15.5	-	15.5	-
07/16	-	15.5	-	17.5	-
07/17	19.5	16.0	17.0	17.5	-
07/18	-	15.8	-	16.5	-
07/19	-	16.5	-	17.0	-
07/20	-	15.5	17.0	15.0	-
07/21	-	15.5	14.0	14.0	-
07/26	-	16.0	-	15.5	-
07/27	-	15.5	-	15.0	-
07/28	-	14.5	-	15.0	-
07/29	-	15.0	15.0	15.0	-
07/30	-	16.0	15.0	16.0	-
07/31	20.0	-	18.0	-	-
08/01	-	-	17.5	17.0	-
08/02	-	-	17.0	17.0	-
08/03	-	17.5	18.0	17.0	-
08/04	-	18.0	17.0	17.0	-
08/09	-	16.5	17.5	17.0	-
08/10	-	18.8	18.5	17.0	-
08/11	-	-	18.0	18.0	-
08/12	-	-	19.5	-	-
08/13	-	-	18.3	17.8	-
08/15	-	-	17.5	-	-
08/23	-	17.0	16.5	-	-
08/24	-	17.0	17.0	-	-
08/28	-	15.0	-	-	-
08/29	-	-	-	15.0	-
08/30	-	-	-	-	-

[a] No data.

Appendix 16b. Water temperatures (°C) in Shuswap and Little Shuswap Lakes, August 2, 1976.

Depth (m)	Shuswap Lake sites[a]		Little Shuswap Lake sites[b]		
	A[c]	B	C	D	E
0	15.0	18.5	14.8(16.3)[d]	17.0(18.4)[d]	15.1
1.5	15.0	18.3	-	-	15.1
2.1	-	-	-	17.0	-
3.0	15.0	17.8	15.5	-	15.0
4.6	15.0	16.0	-	-	14.9
6.1	14.8	14.8	-	-	14.8
7.6	14.3	12.3	15.3	-	14.3
15.2	-	8.3	-	-	-
22.9	-	5.3	-	-	-
30.5	-	5.0	-	-	-

[a] Site A - 150 m from mouth of Adams River (Fig. 2); 18 m deep.
Site B - 2 km west of Scotch Creek (Fig. 2); 59 m deep.

[b] Site C - N.W. Beach; 15 m offshore; 12 m deep.
Site D - N. end; 15 m offshore; 2 m deep.
Site E - Tagging platform, N.E. side; 100 m offshore; 12 m deep.

[c] The cooler and more uniform temperatures observed down to 8 m at station A, compared to station B, may be due to influence of cooler Adams River water outflowing at site A.

[d] Shore water temperature in parenthesis.

Appendix 16c. Surface water temperatures (°C) at South Thompson River seining sites (S), 1976.

Date	S-6	S-7
08/10	18.0	-[a]
08/11	18.0	-
08/12	17.0	-
08/13	17.5	-
08/14	17.0	-
08/15	18.0	-
08/16	-	-
08/17	-	16.0
08/18	15.5	16.0
08/23	-	-
08/24	16.0	-
08/25	-	17.0
08/26	16.0	16.0
08/27	16.0	16.0
08/28	16.0	-
08/29	15.0	-
08/30	-	-

[a] No data.

Appendix 17. Surface water temperatures (°C) at tagging sites, Shuswap - South Thompson River system, 1976.

Tagging date	Temperature date	Tagging	Temperature
Little Shuswap Lake (T-1)			
06/21	14.5	08/01	16.5
06/23	12.0	08.02	15.0
06/30	12.0	08/03	15.5
07/01	12.0	08/04	16.0
07/02	12.0	08/09	17.0
07/03	12.0	08/10	16.0
07/04	12.5	08/11	17.0
07/05	14.0	08/12	17.0
07/06	13.5	08/13	17.0
07/07	13.5		
07/13	15.0	South Thompson River (T-2 & 3)	
07/14	15.5	08/14	17.0
07/15	15.0	08/15	16.5
07/16	17.0	08/16	16.0
07/17	15.7	08/17	16.0
07/18	14.0	08/18	15.5
07/19	14.0	08/23	17.5
07/20	14.0	08/24	17.0
07/21	14.0	08/25	17.0
07/27	14.0	08/26	17.0
07/28	14.5	08/27	17.5
07/29	15.5	08/28	17.5
07/30	16.0	08/29	17.5
07/31	16.5	08/30	17.5

[a] See Fig. 2 for site location.

Appendix 18. Surface water temperatures (°C), water levels and estimated velocities at trap entrances, lower Shuswap River, 1979.

Date	Water temp.	Water level (m)	Water velocity (cm/sec) 4x4	2x3(#1)	2x3(#2)	2x3(IPSFC)
04/12	2.8	-[a]	76	-	-	-
04/13	3.3	-	79	-	46	-
04/14	3.0	-	73	-	70	-
04/15	3.5	-	-	-	-	-
04/16	4.0	-	73	76	82	-
04/17	3.5	-	79	79	73	-
04/18	4.3	-	73	91	79	-
04/19	4.0	-	-	-	-	-
04/20	4.5	0.34	91	76	70	-
04/21	4.8	0.34	104	91	82	-
04/22	5.0	0.33	104	91	88	-
04/23	5.0	0.33	101	70	70	-
04/24	5.3	0.35	91	76	-	-
04/25	4.5	0.36	-	-	-	-
04/26	4.8	0.37	91	91	91	-
04/27	4.8	0.40	-	-	61	-
04/28	5.5	0.45	94	94	94	-
04/29	6.0	0.48	-	98	49	-
04/30	6.0	0.51	98	91	52	-
05/01	7.0	0.56	122	104	55	98
05/02	7.3	0.59	122	98	61	122
05/03	7.8	0.59	122	122	58	122
05/04	7.8	0.68	134	134	70	134
05/05[b]						
05/06	7.3	0.88	122	131	88	134
05/07	7.0	0.91	183	122	122	134
05/08	7.0	0.93	813	98	70	152
05/09	6.0	0.95	183	98	98	79
05/10	6.8	0.96	-	98	82	-
05/11	7.8	0.96	168	82	98	162
05/12	8.5	0.96	168	82	98	162
05/13	7.5	0.96	168	79	98	162
05/14	10.0	0.97	165	110	143	162
05/15	9.3	0.97	165	110	131	162
05/16	9.5	0.97	168	113	131	165
05/17	9.0	0.98	168	113	131	165

[a] No data.

[b] No trapping.

Appendix 19. Water temperatures (T) in rearing pens, Mabel Lake, April to June, 1979, 1980.

1979				1980			
Date	Mean T (°C) [a]	Date	Mean T (°C) [a]	Date	Mean T (°C) [a]	Date	Mean T (°C) [a]
04/26	5.0	05/26	13.0	04/14	-	05/14	11.0
04/27	5.0	05/27	11.1	04/15	5.0	05/15	11.0
04/28	6.0	05/28	11.5	04/16	5.0	05/16	13.0
04/29	6.0	05/29	12.0	04/17	5.5	05/17	13.0
04/30	6.0	05/30	11.4	04/18	6.0	05/18	11.0
05/01	-	05/31	11.8	04/19	5.5	05/19	11.5
05/02	-	06/01	13.9	04/20	5.0	05/20	11.5
05/03	7.0	06/02	14.9	04/21	5.0	05/21	10.5
05/04	7.0	06/03	14.1	04/22	5.5	05/22	10.0
05/05	7.0	06/04	14.2	04/23	6.0	05/23	9.5
05/06	7.0	06/05	-	04/24	8.5	05/24	10.5
05/07	7.0	06/06	12.3	04/25	8.5	05/25	10.5
05/08	7.0	06/07	13.5	04/26	10.0	05/26	10.5
05/09	7.5	06/08	14.5	04/27	10.0	05/27	10.5
05/10	7.5	06/09	16.5	04/28	9.5	05/28	10.5
05/11	14.5	06/10	16.5	04/29	7.5	05/29	11.0
05/12	10.0	06/11	17.0	04/30	10.5	05/30	11.0
05/13	12.0	06/12	16.8	05/01	11.0	05/31	11.5
05/14	13.5	06/13	13.5	05/02	10.0	06/01	10.5
05/15	11.1	06/14	13.5	05/03	11.5	06/02	10.5
05/16	9.3	06/15	13.5	05/04	11.5	06/03	11.0
05/17	10.7	06/16	13.5	05/05	11.5	06/04	11.5
05/18	10.8	06/17	14.5	05/06	9.5	06/05	12.0
05/19	10.5	06/18	15.5	05/07	11.0	06/06	12.0
05/20	8.4	06/19	14.5	05/08	11.0	06/07	12.0
05/21	10.2	06/20	14.5	05/09	11.0	06/08	12.5
05/22	12.8			05/10	12.0	06/09	12.0
05/23	10.3			05/11	13.0		
05/24	12.7			05/12	11.5		
05/25	12.5			05/13	11.5		

[a] $\frac{(\text{Max. T} + \text{Min. T})}{2}$

ppendix 20. Water level (m) at Mabel Lake outlet, April to June, 1979 (from: ater Survey of Canada records; station did not operate in 1980).

Date	Water level (m)	Date	Water level (m)	Date	Water level (m)
4/26	0.99	05/15	1.85	06/03	2.45
4/27	1.00	05/16	1.87	06/04	2.48
4/28	1.03	05/17	1.89	06/05	2.51
4/29	1.07	05/18	1.92	06/06	2.54
4/30	1.12	05/19	1.95	06/07	2.52
5/01	1.19	05/20	1.96	06/08	2.48
5/02	1.25	05/21	1.97	06/09	2.44
5/03	1.31	05/22	1.98	06/10	2.42
5/04	1.41	05/23	2.02	06/11	2.42
5/05	1.53	05/24	2.07	06/12	2.42
5/06	1.64	05/25	2.15	06/13	2.42
5/07	1.72	05/26	2.23	06/14	2.41
5/08	1.77	05/27	2.36	06/15	2.36
5/09	1.79	05/28	2.43	06/16	2.32
5/10	1.81	05/29	2.46	06/17	2.28
5/11	1.83	05/30	2.45	06/18	2.25
5/12	1.84	05/31	2.44	06/19	2.31
5/13	1.84	06/01	2.42	06/20	2.24
5/14	1.84	06/02	2.41		

Appendix 21. Surface water temperatures (°C), water levels and estimated velocities at trap entrances, lower Shuswap River, 1980.

Date	Water temp.	Water level (m)	Water velocity (cm/sec) 4x4 (#1)	4x4 (#2)	2x3 (IPSFC)
04/13	5.5	0.16	62	66	-
04/14	5.0	0.20	-[a]	-	-
04/15	5.0	0.23	70	77	-
04/16	5.0	0.24	-	-	-
04/17	5.0	0.26	70	78	-
04/18	5.0	0.29	-	-	-
04/19	5.0	0.41	104	112	-
04/20	5.0	0.45	-	-	-
04/21	5.0	0.45	84	104	-
04/22	6.0	0.71	-	-	-
04/23	7.0	0.56	102	102	88
04/24	6.0	0.66	-	-	-
04/25	8.0	0.71	84	138	62
04/26	8.0	0.81	-	-	-
04/27	6.5	0.90	125	130	30
04/28	6.0	1.02	-	-	-
04/29	8.0	1.05	155	160	84
04/30	N.A.		-	-	-
05/01	10.0	1.20[c]	-	-	-
05/02	7.0	-	180	-	-
05/03	9.0	1.28[c]	-	-	-

[a] No data.

[b] Water gauge lost.

[c] Estimates using a temporary gauge.

Appendix 22. Water level (m) and flow per pen (1-4), Mabel Lake, 1980.

Date	Water level[a] (m)	Water flow (cm/sec) 1	2	3	4
04/21	0.98	-	-	2.6	3.4
04/23	1.16	2.2	1.4	3.1	3.6
04/25	1.37	-	-	3.8	3.8
04/27	1.58	-	-	1.8	4.6
04/29	1.87	5.5	-	8.3	3.3
05/12	2.52	6.8	8.2	7.3	7.5
05/19	2.46	5.8	8.2	13.0	10.2
05/26	2.41	7.8	6.9	14.0	11.5
06/02	2.37	3.1	7.5	6.0	6.4

[a] Used a temporary water gauge.